ANNA UNIVERSITY, CHENNAI

UNIVERSITY DEPARTMENTS

REGULATIONS – 2015

CHOICE BASED CREDIT SYSTEM

B.E MATERIALS SCIENCE AND ENGINEERING

PROGRAMME EDUCATIONAL OBJECTIVES (PEOs) :

Bachelor of Materials Science and Engineering curriculum is designed

I. To prepare students to excel in research and to succeed in the areas of materials science and metallurgical engineering.

II. To provide students with a solid foundation in mathematical, scientific and engineering fundamentals required to solve materials science and metallurgical engineering problems

III. To train students with scientific and engineering knowledge so as to comprehend, select materials, process, characterize, analyze, design, and develop newer materials and solutions for the real time problems.

IV. To inculcate students with professional and ethical attitude, effective communication skills, teamwork skills and multidisciplinary approach,

V. To develop student with an academic excellence, leadership qualities, leading to life-long learning for a successful professional career

PROGRAMME OUTCOMES (POs):

On successful completion of the programme,

1. Graduates will demonstrate knowledge of mathematics, science and engineering.
2. Graduates will demonstrate an ability to identify, formulate and solve engineering problems.
3. Graduate will demonstrate ability to select the materials, process the materials, identify the suitable process, characterize, design and conduct experiments, analyze and interpret data.
4. Graduates will demonstrate an ability to select materials and process, as per needs and specifications.
5. Graduate will demonstrate skills to develop materials, characterize the materials, and identify the applications of the materials.
6. Graduates will demonstrate knowledge of professional and ethical responsibilities.
7. Graduate will be able to communicate effectively in their technical knowledge.
8. Graduate will understand the impact of engineering solutions on the societal transformation.
9. Graduate will develop confidence for self education and ability for life-long learning.

Attested

DIRECTOR
Centre For Academic Courses
Anna University, Chennai-600 025.

Mapping PEO with POs:

Programme Educational Objectives	Programme Outcomes								
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9
I	✓	✓	✓	✓	✓	✓	✓	✓	✓
II	✓	✓	✓		✓			✓	
III			✓	✓	✓	✓			
IV					✓	✓	✓		✓
V		✓	✓	✓	✓				✓

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MAPPING OF COURSE OUTCOMES WITH PROGRAMME OUTCOMES:											
			PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9
YEAR 1	SEM 1	Foundational English						√	√		√
		Mathematics -I	√	√							
		Engineering Physics	√	√					√		√
		Engineering Chemistry	√						√		√
		Engineering Graphics	√						√		√
		Engineering Mechanics	√	√				√	√		√
		Basic Sciences Laboratory						√	√		√
		Engineering Practices Laboratory						√	√		√
	SEM 2	Technical English						√	√		√
		Mathematics - II	√	√							
		Chemical Reactions Dynamics	√			√					
		Strength of Materials	√	√				√	√		√
		Computing Techniques		√				√	√		√
		Strength of Materials Laboratory						√	√		√
		Computer Practices Laboratory						√	√		√
YEAR 2	SEM III	Applied Statistics	√	√							
		Polymer Science and Engineering	√	√	√	√	√				
		Structure and Properties of Materials			√	√	√		√	√	√
		Casting and Machining Processes		√	√	√	√				
		Electrical and Electronic properties of Materials	√	√	√	√	√				
		Metallurgical Thermodynamics	√	√	√		√				
		Microstructural Analysis Laboratory			√	√	√		√	√	√
		Foundry and Machining Laboratory		√	√	√		√			
	SEM IV	Heat Treatment of Metals and Alloys			√	√	√		√	√	√
		Mechanics of Machines		√	√	√			√		√
		Characterisation of Materials - I	√	√	√	√	√				√
		Iron and Steel Making			√	√	√		√	√	√
		Mechanical Behaviour of Materials	√	√	√	√	√		√		
		Powder Metallurgy			√	√	√		√	√	√

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		Heat Treatment Laboratory			√	√	√		√	√	√
		Powder Metallurgy Laboratory			√	√	√		√	√	√
YEAR 3	**SEM V**	Machine Design	√	√	√				√	√	√
		Characterisation of Materials - II			√		√	√			√
		Environmental Science and Engineering	√	√				√	√	√	√
		Theory and Applications of Metal Forming	√	√	√	√	√		√	√	√
		Professional Elective I									
		Open Elective I									
		Materials Characterisation Lab-1	√	√	√	√	√				√
		Metal Forming Laboratory		√	√	√	√	√		√	
	SEM VI	Industrial Management						√	√	√	√
		Welding Metallurgy		√	√	√					√
		Composite Materials	√		√	√	√		√	√	√
		Nondestructive Evaluation of Materials	√	√		√	√	√	√	√	√
		Professional Elective II									
		Open Elective II									
		Composite Materials Laboratory			√	√	√	√		√	
		Materials Characterisation Laboratory - II		√	√		√				
YEAR 4	**SEM VII**	Surface Engineering	√	√	√	√	√				√
		Nonferrous Metallurgy			√	√	√	√	√		√
		Professional Elective III									
		Professional Elective IV									
		Professional Elective V									
		Surface Engineering Laboratory		√	√	√					
		Creative and Innovative Project	√	√	√	√	√	√	√	√	√
		Industrial Training	√	√	√	√	√	√	√	√	√
	SEM VIII	Professional Elective VI									
		Professional Elective VII									
		Project Work	√	√	√	√	√	√	√	√	√

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ANNA UNIVERSITY, CHENNAI

UNIVERSITY DEPARTMENTS

B.E. MATERIALS SCIENCE AND ENGINEERING

REGULATIONS – 2015

CHOICE BASED CREDIT SYSTEM

CURRICULA AND SYLLABI I - VIII SEMESTERS

SEMESTER I

S. No	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
THEORY								
1.	HS7151	Foundational English	HS	4	4	0	0	4
2.	MA7151	Mathematics -I	BS	4	4	0	0	4
3.	PH7151	Engineering Physics	BS	3	3	0	0	3
4.	CY7151	Engineering Chemistry	BS	3	3	0	0	3
5.	GE7152	Engineering Graphics	ES	5	3	2	0	4
6.	GE7153	Engineering Mechanics	ES	4	4	0	0	4
PRACTICAL								
7.	BS7161	Basic Sciences Laboratory	BS	4	0	0	4	2
8.	GE7162	Engineering Practices Laboratory	ES	4	0	0	4	2
			TOTAL	**31**	**21**	**2**	**8**	**26**

SEMESTER II

S. No	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
THEORY								
1.	HS7251	Technical English	HS	4	4	0	0	4
2.	MA7251	Mathematics - II	BS	4	4	0	0	4
3.	CY7251	Chemical Reactions Dynamics	BS	3	3	0	0	3
4.	CE7251	Strength of Materials	ES	3	3	0	0	3
5.	GE7151	Computing Techniques	ES	3	3	0	0	3
PRACTICAL								
6.	CE7261	Strength of Materials Laboratory	ES	4	0	0	4	2
7.	GE7161	Computer Practices Laboratory	ES	4	0	0	4	2
			TOTAL	**25**	**17**	**0**	**8**	**21**

SEMESTER III

S. No	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
THEORY								
1.	CY7302	Polymer Science and Engineering	PC	3	3	0	0	3
2.	MA7352	Applied Statistics	BS	4	4	0	0	4
3.	ML7301	Casting and Machining Processes	PC	3	3	0	0	3
4.	ML7302	Electrical and Electronic Properties of Materials	BS	3	3	0	0	3
5.	ML7303	Metallurgical Thermodynamics	PC	3	3	0	0	3
6.	ML7304	Structure and Properties of Materials	PC	3	3	0	0	3
PRACTICAL								
7.	ML7311	Foundry and Machining Laboratory	PC	4	0	0	4	2
8.	ML7312	Microstructural Analysis Laboratory	PC	4	0	0	4	2
			TOTAL	**27**	**19**	**0**	**8**	**23**

SEMESTER IV

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
THEORY								
1.	ME7353	Mechanics of Machines	ES	3	3	0	0	3
2.	ML7401	Characterisation of Materials - I	PC	3	3	0	0	3
3.	ML7402	Heat Treatment of Metals and Alloys	PC	3	3	0	0	3
4.	ML7403	Iron and Steel Making	PC	3	3	0	0	3
5.	ML7404	Mechanical Behaviour of Materials	PC	3	3	0	0	3
6.	ML7405	Powder Metallurgy	PC	3	3	0	0	3
PRACTICAL								
7.	ML7411	Heat Treatment Laboratory	PC	4	0	0	4	2
8.	ML7412	Powder Metallurgy Laboratory	PC	4	0	0	4	2
			TOTAL	**26**	**18**	**0**	**8**	**22**

SEMESTER V

S. No	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
THEORY								
1.	GE7251	Environmental Science and Engineering	HS	3	3	0	0	3
2.	ME7451	Machine Design	ES	5	3	2	0	4
3.	ML7501	Characterisation of Materials - II	PC	3	3	0	0	3
4.	ML7502	Theory and Applications of Metal Forming	PC	3	3	0	0	3
5.		Open Elective I*	OE	3	3	0	0	3
6.		Professional Elective I	PE	3	3	0	0	3
PRACTICAL								
7.	ML7511	Materials Chacterisation Lab-I	PC	4	0	0	4	2
8.	ML7512	Metal Forming Laboratory	PC	4	0	0	4	2
			TOTAL	**28**	**18**	**2**	**8**	**23**

SEMESTER VI

S. No	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
THEORY								
1.	ME7554	Industrial Management	ES	3	3	0	0	3
2.	ML7601	Composite Materials	PC	3	3	0	0	3
3.	ML7602	Non-destructive Evaluation of Materials	PC	3	3	0	0	3
4.	ML7603	Welding Metallurgy	PC	3	3	0	0	3
5.		Open Elective II*	OE	3	3	0	0	3
6.		Professional Elective II	PE	3	3	0	0	3
PRACTICAL								
7.	ML7611	Composite Materials Laboratory	PC	4	0	0	4	2
8.	ML7612	Materials Characterisation Laboratory - II	PC	4	0	0	4	2
			TOTAL	**26**	**18**	**0**	**8**	**22**

SEMESTER VII

S. No	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
THEORY								
1.	ML7701	Nonferrous Metallurgy	PC	3	3	0	0	3
2.	ML7751	Surface Engineering	PC	3	3	0	0	3
3.		Professional Elective III	PE	3	3	0	0	3
4.		Professional Elective IV	PE	3	3	0	0	3
5.		Professional Elective V	PE	3	3	0	0	3
PRACTICAL								
6.	ML7711	Creative and Innovative Project	EEC	4	0	0	4	2
7.	ML7712	Surface Engineering Laboratory	PC	4	0	0	4	2
8.	ML7713	Industrial Training*#	EEC	0	0	0	0	2
			TOTAL	**23**	**15**	**0**	**8**	**21**

*four weeks industrial training during sixth semester holidays

SEMESTER VIII

S. No	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
THEORY								
1.		Professional Elective VI	PE	3	3	0	0	3
2.		Professional Elective VII	PE	3	3	0	0	3
PRACTICAL								
3.	ML7811	Project Work	EEC	20	0	0	20	10
			TOTAL	**26**	**6**	**0**	**20**	**16**

TOTAL NO. OF CREDITS:174

***Course from the curriculum of other UG Programmes**

The contact periods will not appear in the slot time table

HUMANITIES AND SOCIAL SCIENCES (HS)

S. No	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1.	HS7151	Foundational English	HS	4	4	0	0	4
2.	HS7251	Technical English	HS	4	4	0	0	4
3.	GE7251	Environmental science and engineering	HS	3	3	0	0	3

BASIC SCIENCES (BS)

S. No	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1.	MA7151	Mathematics -I	BS	4	4	0	0	4
2.	PH7151	Engineering Physics	BS	3	3	0	0	3
3.	CY7151	Engineering Chemistry	BS	3	3	0	0	3
4.	BS7161	Basic Sciences Laboratory	BS	4	0	0	4	2
5.	MA7251	Mathematics - II	BS	4	4	0	0	4
6.	CY7251	Chemical Reactions Dynamics	BS	3	3	0	0	3
7.	MA7352	Applied Statistics	BS	4	4	0	0	4
8.	ML7302	Electrical and Electronic Properties of Materials	BS	3	3	0	0	3

ENGINEERING SCIENCES (ES)

S. No	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1.	GE7152	Engineering Graphics	ES	5	3	2	0	4
2.	GE7153	Engineering Mechanics	ES	4	4	0	0	4
3.	GE7162	Engineering practices laboratory	ES	4	0	0	4	2
4.	CE7251	Strength of Materials	ES	3	3	0	0	3
5.	GE7151	Computing Techniques	ES	3	3	0	0	3
6.	CE7261	Strength of Materials Laboratory	ES	4	0	0	4	2
7.	GE7161	Computer Practices Laboratory	ES	4	0	0	4	2
8.	ME7353	Mechanics of Machines	ES	3	3	0	0	3
9.	ME7451	Machine Design	ES	5	3	2	0	4
10.	ME7554	Industrial Management	ES	3	3	0	0	3

PROFESSIONAL CORE (PC)

S. No	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1.	CY7302	Polymer Science and Engineering	PC	3	3	0	0	3
2.	ML7304	Structure and Properties of Materials	PC	3	3	0	0	3
3.	ML7301	Casting Processes and machining Processes	PC	3	3	0	0	3
4.	ML7303	Metallurgical thermodynamics	PC	3	3	0	0	3
5.	ML7312	Microstructural Analysis Laboratory	PC	4	0	0	4	2
6.	ML7311	Foundry and machining Laboratory	PC	4	0	0	4	2
7.	ML7402	Heat Treatment of Metals and Alloys	PC	3	3	0	0	3
8.	ML7401	Characterisation of Materials-I	PC	3	3	0	0	3
9.	ML7403	Iron and Steel Making	PC	3	3	0	0	3
10.	ML7404	Mechanical Behaviour of Materials	PC	3	3	0	0	3
11.	ML7405	Powder Metallurgy	PC	3	3	0	0	3
12.	ML7411	Heat Treatment Laboratory	PC	4	0	0	4	2
13.	ML7412	Powder Metallurgy Laboratory	PC	4	0	0	4	2
14.	ML7501	Characterisation of Materials - II	PC	3	3	0	0	3
15.	ML7502	Theory and Applications of Metal Forming	PC	3	3	0	0	3
16.	ML7511	Materials Characterisation lab-I	PC	4	0	0	4	2
17.	ML7512	Metal Forming Laboratory	PC	4	0	0	4	2
18.	ML7603	Welding Metallurgy	PC	3	3	0	0	3
19.	ML7601	Composite Materials	PC	3	3	0	0	3
20.	ML7602	Non-Destructive Evaluation of Materials	PC	3	3	0	0	3
21.	ML7611	Composite Materials Laboratory	PC	4	0	0	4	2
22.	ML7612	Materials Characterisation Laboratory - II	PC	4	0	0	4	2
23.	ML7751	Surface Engineering	PC	3	3	0	0	3
24.	ML7701	Nonferrous Metallurgy	PC	3	3	0	0	3
25.	ML7712	Surface Engineering Laboratory	PC	4	0	0	4	2

PROFESSIONAL ELECTIVES (PE)

SL. NO	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1.	GE7071	Disaster Management	PE	3	3	0	0	3
2.	GE7074	Human Rights	PE	3	3	0	0	3
3.	GE7652	Total Quality Management	PE	3	3	0	0	3
4.	IE7751	Design of Experiments	PE	3	3	0	0	3
5.	ME7020	Applied Thermal Engineering	PE	3	3	0	0	3
6.	ME7071	Automobile Engineering	PE	3	3	0	0	3
7.	ME7077	Entrepreneurship Development	PE	3	3	0	0	3
8.	ME7080	Marketing Management	PE	3	3	0	0	3
9.	ME7351	Design concepts in Engineering	PE	3	3	0	0	3
10.	ME7751	Finite Element Analysis	PE	3	3	0	0	3
11.	MF7071	Additive Manufacturing Technology	PE	3	3	0	0	3
12.	MF7651	Non-traditional Machining Processes	PE	3	3	0	0	3
13.	ML7001	Bio and Smart Materials	PE	3	3	0	0	3
14.	ML7002	Casting Processes	PE	3	3	0	0	3
15.	ML7003	Computer Applications in Materials Science	PE	3	3	0	0	3
16.	ML7004	Creep and Fatigue Behaviour of Materials	PE	3	3	0	0	3
17.	ML7005	Cryogenic Treatment of Materials	PE	3	3	0	0	3
18.	ML7006	Electron Microscopy and Diffraction Analysis of Materials	PE	3	3	0	0	3
19.	ML7007	Energy Storing Devices and Fuel Cells	PE	3	3	0	0	3
20.	ML7008	Fracture Mechanics and Failure Analysis	PE	3	3	0	0	3
21.	ML7009	Fuels, Furnaces and Refractories	PE	3	3	0	0	3
22.	ML7010	Industrial Tribology	PE	3	3	0	0	3
23.	ML7011	Introduction to Transport Phenomena	PE	3	3	0	0	3
24.	ML7012	Laser Processing of Materials	PE	3	3	0	0	3
25.	ML7013	Making and Metallurgy of Stainless Steels	PE	3	3	0	0	3
26.	ML7014	Materials for Automotive Application	PE	3	3	0	0	3

27.	ML7015	Metallurgy of Tool Materials	PE	3	3	0	0	3
28.	ML7016	Micro Machining and Fabrication	PE	3	3	0	0	3
29.	ML7017	Modeling and Simulation in Materials Engineering	PE	3	3	0	0	3
30.	ML7018	Nanostructured Materials	PE	3	3	0	0	3
31.	ML7019	Phase Transformations	PE	3	3	0	0	3
32.	ML7020	Principles of Metal Cutting	PE	3	3	0	0	3
33.	ML7021	Reliability Concepts in Engineering	PE	3	3	0	0	3
34.	ML7022	Thin Film Technology	PE	3	3	0	0	3
35.	GE7072	Foundation Skills in Integrated Product Development	PE	3	3	0	0	3

EMPLOYABILITY ENHANCEMENT COURSES (EEC)

S. No	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1.	ML7711	Creative and Innovative Project	EEC	4	0	0	4	2
2.	ML7713	Industrial Training*#	EEC	0	0	0	0	2
3.	ML7811	Project Work	EEC	20	0	0	20	10

SUMMARY

S.NO.	SUBJECT AREA	CREDITS AS PER SEMESTER								CREDITS TOTAL
		I	II	III	IV	V	VI	VII	VIII	
1.	HS	04	04	00	00	03	00	00	00	**11**
2.	BS	12	07	07	00	00	00	00	00	**26**
3.	ES	10	10	00	03	04	03	00	00	**30**
4.	PC	00	00	16	19	10	13	08	00	**66**
5.	PE	00	00	00	00	03	03	09	06	**21**
6.	OE	00	00	00	00	03	03	00	00	**06**
7.	EEC	00	00	00	00	00	00	04	10	**14**
	Total	**26**	**21**	**23**	**22**	**23**	**22**	**21**	**16**	**174**
8.	**Non Credit / Mandatory**									

HS7151 FOUNDATIONAL ENGLISH L T P C
4 0 0 4

COURSE DESCRIPTION:
This course aims at developing the language skills necessary for the first year students of Engineering and Technology.

OBJECTIVES:
- To develop the four language skills – Listening, Speaking, Reading and Writing.
- To improve the students' communicative competence in English.
- To teach students the various aspects of English language usage.

CONTENTS

UNIT I GREETING AND INTRODUCING ONESELF 12
Listening- Types of listening – Listening to short talks, conversations; **Speaking** – Speaking about one's place, important festivals etc. – Introducing oneself, one's family/ friend; **Reading** – Skimming a passage– Scanning for specific information; **Writing**- Guided writing - Free writing on any given topic (My favourite place/ Hobbies/ School life, writing about one's leisure time activities, hometown, etc.); **Grammar –** Tenses (present and present continuous) -Question types - Regular and irregular verbs; **Vocabulary** – Synonyms and Antonyms.

UNIT II GIVING INSTRUCTIONS AND DIRECTIONS 12
Listening – Listening and responding to instructions; **Speaking** – Telephone etiquette - Giving oral instructions/ Describing a process – Asking and answering questions; **Reading** – Reading and finding key information in a given text - Critical reading - **Writing –**Process description(non-technical)- **Grammar –** Tense (simple past& past continuous) - Use of imperatives – Subject – verb agreement – Active and passive voice; - **Vocabulary** – Compound words – Word formation – Word expansion (root words).

UNIT III READING AND UNDERSTANDING VISUAL MATERIAL 12
Listening- Listening to lectures/ talks and completing a task; **Speaking** –Role play/ Simulation – Group interaction; **Reading** – Reading and interpreting visual material; **Writing**- Jumbled sentences – Discourse markers and Cohesive devices – Essay writing (cause & effect/ narrative);**Grammar** – Tenses (perfect), Conditional clauses –Modal verbs; **Vocabulary** –Cause and effect words; Phrasal verbs in context.

UNIT IV CRITICAL READING AND WRITING 12
Listening- Watching videos/ documentaries and responding to questions based on them; **Speaking** Informal and formal conversation; **Reading** –Critical reading (prediction & inference);**Writing**–Essay writing (compare & contrast/ analytical) – Interpretation of visual materials; **Grammar** – Tenses (future time reference);**Vocabulary** – One word substitutes (with meanings) – Use of abbreviations & acronyms – Idioms in sentences.

UNIT V LETTER WRITING AND SENDING E-MAILS 12
Listening- Listening to programmes/broadcast/ telecast/ podcast; **Speaking** – Giving impromptu talks, Making presentations on given topics- Discussion on the presentation; **Reading** –Extensive reading; **Writing**- Poster making – Letter writing (Formal and E-mail) ;**Grammar** – Direct and Indirect speech – Combining sentences using connectives; **Vocabulary** –Collocation;

TEACHING METHODS:
Interactive sessions for the speaking module.
Use of audio – visual aids for the various listening activities.
Contextual Grammar Teaching.

EVALUATION PATTERN:
Internals – 50%
End Semester – 50%

TOTAL:60 PERIODS

OUTCOMES:

- Students will improve their reading and writing skills
- Students will become fluent and proficient in communicative English
- Students will be able to improve their interpersonal communication

TEXTBOOK:

1. Richards, Jack.C with Jonathan Hull and Susan Proctor **New Interchange : English for International Communication. (level2, Student's Book)** Cambridge University Press,New Delhi: 2010.

REFERENCES:

1. Bailey, Stephen. **Academic Writing: A practical guide for students**. New York: Rutledge,2011.
2. Morgan, David and Nicholas Regan. **Take-Off: Technical English for Engineering**. London: Garnet Publishing Limited, 2008.
3. Redston, Chris & Gillies Cunningham **Face2Face** (Pre-intermediate Student's Book& Workbook) Cambridge University Press, New Delhi: 2005
4. Comfort, Jeremy, et al. **Speaking Effectively : Developing Speaking Skillsfor Business English.** Cambridge University Press, Cambridge: Reprint 2011.

MA7151	MATHEMATICS – I (Common to all branches of B.E. / B.Tech. Programmes in I Semester)	L	T	P	C
		4	0	0	4

OBJECTIVES:

- The goal of this course is for students to gain proficiency in calculus computations. In calculus, we use three main tools for analyzing and describing the behavior of functions: limits, derivatives, and integrals. Students will use these tools to solve application problems in a variety of settings ranging from physics and biology to business and economics.
- To make the student acquire sound knowledge of techniques in solving ordinary differential equations that model engineering problems.
- To familiarize the student with functions of several variables. This is needed in many branches of engineering.
- To acquaint the student with mathematical tools needed in evaluating multiple integrals and their usage.

UNIT I DIFFERENTIAL CALCULUS 12

Representation of functions - New functions from old functions - Limit of a function - Limits at infinity - Continuity - Derivatives - Differentiation rules - Polar coordinate system - Differentiation in polar coordinates - Maxima and Minima of functions of one variable.

UNIT II FUNCTIONS OF SEVERAL VARIABLES 12

Partial derivatives – Homogeneous functions and Euler's theorem – Total derivative – Differentiation of implicit functions – Change of variables – Jacobians – Partial differentiation of implicit functions – Taylor's series for functions of two variables – Errors and approximations – Maxima and minima of functions of two variables – Lagrange's method of undetermined multipliers.

UNIT III INTEGRAL CALCULUS 12

Definite and Indefinite integrals - Substitution rule - Techniques of Integration - Integration by parts, Trigonometric integrals, Trigonometric substitutions, Integration of rational functions by partial fraction, Integration of irrational functions - Improper integrals.

UNIT IV MULTIPLE INTEGRALS 12

Double integrals – Change of order of integration – Double integrals in polar coordinates – Area enclosed by plane curves – Triple integrals – Volume of solids – Change of variables in double and triple integrals.

UNIT V DIFFERENTIAL EQUATIONS 12

Method of variation of parameters – Method of undetermined coefficients – Homogenous equation of Euler's and Legendre's type – System of simultaneous linear differential equations with constant coefficients.

TOTAL: 60 PERIODS

OUTCOMES:

- Understanding of the ideas of limits and continuity and an ability to calculate with them and apply them.
- Improved facility in algebraic manipulation.
- Fluency in differentiation.
- Fluency in integration using standard methods, including the ability to find an appropriate method for a given integral.
- Understanding the ideas of differential equations and facility in solving simple standard examples.

TEXTBOOKS:

1. James Stewart, "Calculus with Early Transcendental Functions", Cengage Learning, New Delhi, 2008.
2. Narayanan S. and Manicavachagom Pillai T. K., "Calculus" Volume I and II, S. Viswanathan Publishers Pvt. Ltd., Chennai, 2007.
3. Erwin Kreyszig, "Advanced Engineering Mathematics", John Wiley and Sons, 9th Edition, New Delhi, 2014.
4. Grewal B.S., "Higher Engineering Mathematics", Khanna Publishers, New Delhi, 43rd Edition, 2014.

REFERENCES:

1. Ramana B.V., "Higher Engineering Mathematics", Tata McGraw Hill Co. Ltd., New Delhi, 11th Reprint, 2010.
2. Jain R.K. and Iyengar S.R.K., "Advanced Engineering Mathematics", Narosa Publications, New Delhi, 3rd Edition, 2007.
3. Bali N., Goyal M. and Watkins C., "Advanced Engineering Mathematics", Firewall Media (An imprint of Lakshmi Publications Pvt., Ltd.,), New Delhi, 7th Edition, 2009.
4. Greenberg M.D., "Advanced Engineering Mathematics", Pearson Education, New Delhi, 2nd Edition, 5th Reprint, 2009.
5. Peter V.O'Neil, "Advanced Engineering Mathematics", Cengage Learning India Pvt., Ltd, New Delhi, 2007.

PH7151 **ENGINEERING PHYSICS** **L T P C**

(Common to all branches of B.E / B.Tech programmes) **3 0 0 3**

OBJECTIVE:

- To introduce the concept and different ways to determine moduli of elasticity and applications.
- To instill the concept of sound, reverberation, noise cancellation, and ultrasonic generation, detection and applications
- To inculcate an idea of thermal properties of materials, heat flow through materials and quantum physics
- To promote the basic understanding of interferometers, principles and applications of lasers, optical fibers and sensors
- To establish a sound grasp of knowledge on the basics, significance and growth of single crystals

UNIT I PROPERTIES OF MATTER **9**

Elasticity – Poisson's ratio and relationship between moduli (qualitative) - stress-strain diagram for ductile and brittle materials, uses - factors affecting elastic modulus and tensile strength - bending of beams - cantilever - bending moment - Young's modulus determination - theory and experiment - uniform and non-uniform bending - I shaped girders - twisting couple - hollow cylinder - shaft - torsion pendulum - determination of rigidity modulus- moment of inertia of a body (regular and irregular).

UNIT II ACOUSTICS AND ULTRASONICS **9**

Classification of sound - loudness and intensity - Weber-Fechner Law - standard intensity and intensity level - decibel - reverberation - reverberation time - calculation of reverberation time for different types of buildings – sound absorbing materials - factors affecting acoustics of buildings : focussing, interference, echo, echelon effect, resonance - noise and their remedies. Ultrasonics: production - magnetostriction and piezoelectric methods - detection of ultrasound - acoustic grating – ultrasonic interferometer - industrial applications – Non-destructive testing - ultrasonic method: scan modes and practice.

UNIT III THERMAL AND MODERN PHYSICS **9**

Thermal expansion - thermal stress - expansion joints - bimetallic strips - thermal conductivity- heat conductions in solids – flow of heat through compound media - Forbe's and Lee's disc method: theory and experiment- Black body radiation – Planck's theory (derivation) – Compton effect – wave model of radiation and matter – Schrödinger's wave equation – time dependent and independent equations – Physical significance of wave function – particle in a one dimensional box.

UNIT IV APPLIED OPTICS **9**

Interference - Michelson interferometer: construction, working, determination of wave length and thickness - anti-reflection coating - air wedge and its applications - Lasers – principle and applications – Einstein's coefficients – CO_2 and Nd:YAG laser - semiconductor lasers: homo junction and hetro junction - construction and working – applications. Optical fibres - classification (index & mode based) - principle and propagation of light in optical fibres - acceptance angle and numerical aperture - fibre optic communication system - active and passive sensors.

UNIT V CRYSTAL PHYSICS **9**

Single crystalline, polycrystalline and amorphous materials – Single crystals: unit cell, crystal systems, Bravais lattices, ditections and planes in a crystal, Miller indices - interplanar distance for a cubic crystal - coordination number and packing factor for SC, BCC, FCC, HCP and diamond structures - structure and significance of NaCl, CsCl, ZnS and graphite - crystal imperfections: point defects, line defects – Burger vectors, dislocations and stacking faults – Growth of single crystals: Bridgman and Czochralski methods.

TOTAL: 45 PERIODS

OUTCOME:

- The students will understand different moduli of elasticity, their determination and applications.
- The students will gain knowledge on the properties of sound, noise cancellation, and production, detection and applications of ultrasonics
- The students will acquire sound knowledge on thermal expansion and thermal conductivity of materials. Further they will gain an idea of quantum physics.
- The students will gain knowledge on interferometers, lasers and fiber optics
- The students will secure knowledge on the basics of crystal structures and their significance. Further they gain basic ideas of growing single crystals.

TEXTBOOKS:

1. Gaur R.K. and Gupta S.L., "Engineering Physics", Dhanpat Rai Publications (2013)
2. Palanisamy P.K., "Engineering Physics", Scitech Publications (P) Ltd. (2006).
3. Arumugam M., "Engineering Physics", Anuradha Publications (2000)

REFERENCES:

1. Serway R.A. and Jewett, J.W. "Physics for Scientists and Engineers with Modern Physics". Brooks/cole Publishing Co. (2010).
2. Tipler P.A. and Mosca, G.P., "Physics for Scientists and Engineers with Modern Physics". W.H.Freeman, (2007).
3. Markert J.T.,Ohanian, H. and Ohanian, M. "Physics for Engineers and Scientists". W.W.Norton & Co. (2007).

CY7151 ENGINEERING CHEMISTRY

L	T	P	C
3	0	0	3

OBJECTIVE

- To develop an understanding about fundamentals of polymer chemistry.
- Brief elucidation on surface chemistry and catalysis.
- To develop sound knowledge photochemistry and spectroscopy.
- To impart basic knowledge on chemical thermodynamics.
- To understand the basic concepts of nano chemistry.

UNIT I POLYMER CHEMISTRY 9

Introduction: Functionality-degree of polymerization. Classification of polymers- natural and synthetic, thermoplastic and thermosetting. Types and mechanism of polymerization: addition (free radical, cationic, anionic and living); condensation and copolymerization. Properties of polymers: Tg, tacticity, molecular weight-weight average, number average and polydispersity index. Techniques of polymerization: Bulk, emulsion, solution and suspension.

UNIT II SURFACE CHEMISTRYAND CATALYSIS 9

Adsorption-Types of adsorption-adsorption of gases on solids- adsorption from solutions-Types of isotherms–Frendlich adsorption isotherm, Langmuir adsorption isotherm. Industrial applications of adsorption. Catalysis: Characteristics and types of catalysts-homogeneous and heterogeneous, auto catalysis. Enzyme catalysis -factors affecting enzyme catalysis, Michaelis-Menton equation.Industrial applications of catalysts.

UNIT III PHOTOCHEMISTRY AND SPECTROSCOPY 9

Photochemistry: Laws of photochemistry-Grotthuss-Draper law, Stark-Einstein law and Lambert-Beer Law. Photo processes-internal conversion, inter-system crossing, fluorescence, phosphorescence, chemiluminescence and photo-sensitization. Spectroscopy: Electromagnetic spectrum-absorption of radiation-electronic, vibrational and rotational transitions. Width and intensities of spectral lines. Spectrophotometric estimation of iron. UV-Vis and IR spectroscopy- principles, instrumentation (Block diagram) and applications.

UNIT IV CHEMICAL THERMODYNAMICS 9

Second law: Entropy-entropy change for an ideal gas, reversible and irreversible processes; entropy of phase transitions; Free energy and work function: Helmholtzand Gibbs free energy functions; Criteria of spontaneity; Gibbs-Helmholtz equation; Clausius Clapeyron equation; Maxwell relations-Van't Hoff isotherm and isochore. Chemical potential; Gibbs-Duhem equation- variation of chemical potential with temperature and pressure.

UNIT V NANOCHEMISTRY 9

Basics-distinction between molecules, nanoparticles and bulk materials; size-dependent properties. Preparation of nanoparticles – sol-gel and solvothermal.Preparation of carbon nanotube by chemical vapour deposition and laser ablation.Preparation of nanowires by VLS growth, electrochemical deposition and electro spinning.Properties and uses of nanoparticles, nanoclusters, nanorods, nanotubes and nanowires.

TOTAL: 45 PERIODS

OUTCOME

- Will be familiar with polymer chemistry, surface chemistry and catalysis.
- Will know the photochemistry, spectroscopy and chemical thermodynamics.
- Will know the fundamentals of nano chemistry.

TEXT BOOKS

1. Jain P. C. & Monica Jain., "Engineering Chemistry", DhanpatRai Publishing Company (P) Ltd, New Delhi, 2014.
2. Kannan P., Ravikrishnan A., "Engineering Chemistry", Sri Krishna Hitech Publishing Company Pvt. Ltd. Chennai, 2014

REFERENCES

1. Pahari A., Chauhan B., "Engineering Chemistry", Firewall Media, New Delhi, 2012.
2. Sivasankar B., "Engineering Chemistry", Tata McGraw-Hill Publishing Company Ltd, New Delhi, 2012.
3. AshimaSrivastava. Janhavi N N, Concepts of Engineering Chemistry", ACME Learning Private Limited., New Delhi., 2010.
4. Vairam S., Kalyani P., Suba Ramesh., "Engineering Chemistry", Wiley India Pvt Ltd., New Delhi., 2011.

GE7152 ENGINEERING GRAPHICS L T P C
3 2 0 4

OBJECTIVES

• To develop in students, graphic skills for communication of concepts, ideas and design of engineering products and expose them to existing national standards related to technical drawings.

CONCEPTS AND CONVENTIONS (NOT FOR EXAMINATION) 1

Importance of graphics in engineering applications – Use of drafting instruments – BIS conventions and specifications – Size, layout and folding of drawing sheets – Lettering and dimensioning.

UNIT I PLANE CURVES AND FREE HANDSKETCHING 14

Basic Geometrical constructions, Curves used in engineering practices-Conics – Construction of ellipse, parabola and hyperbola by eccentricity method – Construction of cycloid – construction of involutes of square and circle – Drawing of tangents and normal to the above curves. Visualization concepts and Free Hand sketching: Visualization principles – Representation of Three Dimensional objects – Layout of views- Free hand sketching of multiple views from pictorial views of objects

UNIT II PROJECTION OF POINTS, LINES AND PLANE SURFACES 14

Orthographic projection- principles-Principal planes-First angle projection-Projection of points. Projection of straight lines (only First angle projections) inclined to both the principal planes-Determination of true lengths and true inclinations by rotating line method and trapezoidal method and traces Projection of planes (polygonal and circular surfaces) inclined to both the principal planes by rotating object method.

UNIT III PROJECTION OF SOLIDS 14

Projection of simple solids like prisms, pyramids, cylinder, cone and truncated solids when the axis is inclined to both the principal planes by rotating object method and auxiliary plane method.

UNIT IV PROJECTION OF SECTIONED SOLIDS AND DEVELOPMENT OF SURFACES 14

Sectioning of solids in simple vertical position when the cutting plane is inclined to the one of the principal planes and perpendicular to the other – obtaining true shape of section.

Development of lateral surfaces of simple and sectioned solids – Prisms, pyramids cylinders and cones. Development of lateral surfaces of solids with cut-outs and holes.

UNIT V ISOMETRIC AND PERSPECTIVE PROJECTIONS 15

Principles of isometric projection – isometric scale –Isometric projections of simple solids and truncated solids - Prisms, pyramids, cylinders, cones- combination of two solid objects in simple vertical positions and miscellaneous problems.

Perspective projection of simple solids-Prisms, pyramids and cylinders by visual ray method and vanishing point method.

COMPUTER AIDED DRAFTING (DEMONSTRATION ONLY) 3

Introduction to drafting packages and demonstration of their use.

L=45+T=30, TOTAL: 75 PERIODS

OUTCOMES:

On Completion of the course the student will be able to

- Perform free hand sketching of basic geometrical shapes and multiple views of objects.
- Draw orthographic projections of lines, planes and solids
- Obtain development of surfaces.
- Prepare isometric and perspective views of simple solids.

TEXT BOOK:

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

REFERENCES:

1. K.R.Gopalakrishna., “Engineering Drawing” (Vol I&II combined) SubhasStores, Bangalore, 2007
2. Luzzader, Warren.J., and Duff,John 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
3. M.B.Shah and B.C.Rana, “Engineering Drawing”, Pearson, 2nd Edition, 2009
4. K.Venugopal and V.Prabhu Raja, “Engineering Graphics”, New Age International (P)Limited ,2008.
5. K. V.Natarajan, “A text book of Engineering Graphics”, 28th Edition, Dhanalakshmi Publishers, Chennai, 2015.
6. BasantAgarwal and Agarwal C.M., “Engineering Drawing”, Tata McGraw Hill Publishing Company Limited, New Delhi, 2008.
7. N.S Parthasarathy and Vela Murali, “ Engineering Drawing”, Oxford University Press, 2015

Publication of Bureau of Indian Standards:

1. IS 10711 – 2001: Technical products Documentation – Size and lay out ofdrawing sheets
2. IS 9609 (Parts 0 & 1) – 2001: Technical products Documentation – Lettering.
3. IS 10714 (Part 20) – 2001 & SP 46 – 2003: Lines for technical drawings.
4. IS 11669 – 1986 & SP 46 – 2003: Dimensioning of Technical Drawings.
5. IS 15021 (Parts 1 to 4) – 2001: Technical drawings – Projection Methods.

Special points applicable to University Examinations on Engineering Graphics:

1. There will be five questions, each of either or type covering all units of the syllabus.
2. All questions will carry equal marks of 20 each making a total of 100.
3. The answer paper shall consist of drawing sheets of A3 size only. The students will be permitted to use appropriate scale to fit solution within A3 size.
4. The examination will be conducted in appropriate sessions on the same day.

GE7153 ENGINEERING MECHANICS

L	T	P	C
4	0	0	4

OBJECTIVE :

- The objective of this course is to inculcate in the student the ability to analyze any problem in a simple and logical manner and to predict the physical phenomena and thus lay the foundation for engineering applications.

UNIT I STATICS OF PARTICLES **12**

Fundamental Concepts and Principles, Systems of Units, Method of Problem Solutions, Statics of Particles -Forces in a Plane, Resultant of Forces, Resolution of a Force into Components, Rectangular Components of a Force, Unit Vectors.

Equilibrium of a Particle- Newton's First Law of Motion, Space and Free-Body Diagrams, Forces in Space, Equilibrium of a Particle in Space.

UNIT II EQUILIBRIUM OF RIGID BODIES **12**

Principle of Transmissibility, Equivalent Forces, Vector Product of Two Vectors, Moment of a Force about a Point ,Varignon's Theorem, Rectangular Components of the Moment of a Force, Scalar Product of Two Vectors, Mixed Triple Product of Three Vectors, Moment of a Force about an Axis, Couple - Moment of a Couple, Equivalent Couples, Addition of Couples, Resolution of a Given Force into a Force -Couple system, Further Reduction of a System of Forces, Equilibrium in Two and Three Dimensions - Reactions at Supports and Connections.

UNIT III DISTRIBUTED FORCES **16**

Centroids of lines and areas – symmetrical and unsymmetrical shapes, Determination of Centroids by Integration , Theorems of Pappus-Guldinus, Distributed Loads on Beams, Center of Gravity of a Three-Dimensional Body, Centroid of a Volume, Composite Bodies , Determination of Centroids of Volumes by Integration.

Moments of Inertia of Areas and Mass - Determination of the Moment of Inertia of an Area by Integration , Polar Moment of Inertia , Radius of Gyration of an Area , Parallel-Axis Theorem , Moments of Inertia of Composite Areas, Moments of Inertia of a Mass - Moments of Inertia of Thin Plates , Determination of the Moment of Inertia of a Three-Dimensional Body by Integration.

UNIT IV FRICTION **8**

The Laws of Dry Friction. Coefficients of Friction, Angles of Friction, Wedges, Wheel Friction. Rolling Resistance , Ladder friction.

UNIT V DYNAMICS OF PARTICLES 12

Kinematics - Rectilinear Motion and Curvilinear Motion of Particles.

Kinetics- Newton's Second Law of Motion -Equations of Motions , Dynamic Equilibrium, Energy and Momentum Methods - Work of a Force , Kinetic Energy of a Particle, Principle of Work and Energy, Principle of Impulse and Momentum, Impact, Method of Virtual Work - Work of a Force, Potential Energy, Potential Energy and Equilibrium.

L – 45 + T – 15 TOTAL: 60 PERIODS

OUTCOMES:

- Upon completion of this course, students will be able to construct meaningful mathematical models of physical problems and solve them.

TEXT BOOK

1. Beer,F.P and Johnson Jr. E.R, "Vector Mechanics for Engineers", McGraw-Hill Education (India) Pvt. Ltd. 10th Edition, 2013.

REFERENCES

1. Hibbeller, R.C., Engineering Mechanics: Statics, and Engineering Mechanics: Dynamics, 13th edition, Prentice Hall, 2013.
2. J.L. Meriam & L.G. Karige, Engineering Mechanics: Statics (Volume I) and Engineering Mechanics: Dynamics, 7th edition, Wiley student edition, 2013.
3. P. Boresi & J. Schmidt, Engineering Mechanics: Statics and Dynamics, 1/e, Cengage learning, 2008.
4. Irving H. Shames, G. Krishna Mohana Rao, Engineering Mechanics - Statics and Dynamics, Fourth Edition – PHI / Pearson Education Asia Pvt. Ltd., 2006.
5. Vela Murali, "Engineering Mechanics", Oxford University Press (2010)

BS7161 BASIC SCIENCES LABORATORY L T P C

(Common to all branches of B.E. / B.Tech Programmes) **0 0 4 2**

PHYSICS LABORATORY: (Any Seven Experiments)

OBJECTIVE:

- To inculcate experimental skills to test basic understanding of physics of materials including properties of matter, thermal and optical properties.
- To induce the students to familiarize with experimental determination of velocity of ultrasonic waves, band gap determination and viscosity of liquids.

1. Torsional pendulum - Determination of rigidity modulus of wire and moment of inertia of disc
2. Non-uniform bending - Determination of young's modulus
3. Uniform bending – Determination of young's modulus
4. Lee's disc Determination of thermal conductivity of a bad conductor
5. Potentiometer-Determination of thermo e.m.f of a thermocouple
6. Laser- Determination of the wave length of the laser using grating
7. Air wedge - Determination of thickness of a thin sheet/wire
8. a) Optical fibre -Determination of Numerical Aperture and acceptance angle
   b) Compact disc- Determination of width of the groove using laser.
9. Acoustic grating- Determination of velocity of ultrasonic waves in liquids.
10. Ultrasonic interferometer – determination of the velocity of sound and compressibility of liquids
11. Post office box -Determination of Band gap of a semiconductor.
12. Spectrometer- Determination of wavelength using gating.
13. Viscosity of liquids - Determination of co-efficient of viscosity of a liquid by Poiseuille"s flow

OUTCOMES:

- To determine various moduli of elasticity and also various thermal and optical properties of materials.
- To determine the velocity of ultrasonic waves, band gap determination and viscosity of liquids.

CHEMISTRY LABORATORY:
(Minimum of 8 experiments to be conducted)

1. Estimation of HCl using Na_2CO_3 as primary standard and Determination of alkalinity in water sample.
2. Determination of total, temporary & permanent hardness of water by EDTA method.
3. Determination of DO content of water sample by Winkler's method.
4. Determination of chloride content of water sample by argentometric method.
5. Estimation of copper content of the given solution by Iodometry.
6. Determination of strength of given hydrochloric acid using pH meter.
7. Determination of strength of acids in a mixture of acids using conductivity meter.
8. Estimation of iron content of the given solution using potentiometer.
9. Estimation of iron content of the water sample using spectrophotometer (1, 10-Phenanthroline/thiocyanate method).
10. Estimation of sodium and potassium present in water using flame photometer.
11. Determination of molecular weight of poly vinyl alcohol using Ostwald viscometer.
12. Pseudo first order kinetics-ester hydrolysis.
13. Corrosion experiment-weight loss method.
14. Determination of CMC.
15. Phase change in a solid.

TOTAL: 60 PERIODS

TEXTBOOKS

1. Vogel's Textbook of Quantitative Chemical Analysis (8^{TH} edition, 2014)
2. Laboratory Manual- Department of Chemistry, CEGC, Anna University (2014).

GE7162	ENGINEERING PRACTICES LABORATORY (Common to all Branches of B.E. / B.Tech. Programmes)	L	T	P	C
		0	0	4	2

OBJECTIVES

To provide exposure to the students with hands-on experience on various Basic Engineering Practices in Civil, Mechanical, Electrical and Electronics Engineering.

GROUP – A (CIVIL & ELECTRICAL)

1. CIVIL ENGINEERING PRACTICES **15**

PLUMBING

Basic pipe connections involving the fittings like valves, taps, coupling, unions, reducers, elbows and other components used in household fittings. Preparation of plumbing line sketches.

• Laying pipe connection to the suction side of a pump.
• Laying pipe connection to the delivery side of a pump.
• Practice in connecting pipes of different materials: Metal, plastic and flexible pipes used in household appliances.

WOOD WORK

Sawing, planing and making joints like T-Joint, Mortise and Tenon joint and Dovetail joint.

STUDY

- Study of joints in door panels and wooden furniture
- Study of common industrial trusses using models.

2. ELECTRICAL ENGINEERING PRACTICES **15**

- Basic household wiring using Switches, Fuse, Indicator and Lamp etc.,
- Stair case light wiring
- Tube – light wiring
- Preparation of wiring diagrams for a given situation.
- Study of Iron-Box, Fan Regulator andEmergency Lamp

GROUP – B (MECHANICAL AND ELECTRONICS) **15**

3. MECHANICAL ENGINEERING PRACTICES

WELDING

- Arc welding of Butt Joints, Lap Joints, and Tee Joints
- Gas welding Practice.
- Basic Machining - Simple turning, drilling and tapping operations..
- Study and assembling of the following:
  a. Centrifugal pump
  b. Mixie
  c. Air Conditioner.

DEMONSTRATION ON FOUNDRY OPERATIONS.

4. ELECTRONIC ENGINEERING PRACTICES **15**

- Soldering simple electronic circuits and checking continuity.
- Assembling electronic components on a small PCB and Testing.
- Study of Telephone, FM radio and Low Voltage Power supplies.

TOTAL: 60 PERIODS

OUTCOMES

- Ability to fabricate carpentry components and to lay pipe connections including plumbing works.
- Ability to use welding equipments to join the structures
- Ability to do wiring for electrical connections and to fabricate electronics circuits.

HS7251 **TECHNICAL ENGLISH** **L T P C**
4 0 0 4

OBJECTIVES

- To enable students acquire proficiency in technical communication.
- To enhance their reading and writing skills in a technical context.
- To teach various language learning strategies needed in aprofessional environment.

CONTENTS

UNIT I ANALYTICAL READING **12**

Listening- Listening to informal and formal conversations; **Speaking** – Conversation Skills(opening, turn taking, closing)-explaining how something works-describing technical functions and applications; **Reading** –Analytical reading, Deductive and inductive reasoning; **Writing**- vision statement–structuring paragraphs.

UNIT II SUMMARISING 12

Listening- Listening to lectures/ talks on Science & Technology; **Speaking** –Summarizing/ Oral Reporting, **Reading** – Reading Scientific and Technical articles; **Writing**- Extended definition –Lab Reports – Summary writing.

UNIT III DESCRIBING VISUAL MATERIAL 12

Listening- Listening to a panel discussion; **Speaking** – Speaking at formal situations; **Reading** – Reading journal articles - Speed reading; **Writing**-data commentary-describing visual material-writing problem-process- solution-the structure of problem-solution texts- writing critiques

UNIT IV WRITING/ E-MAILING THE JOB APPLICATION 12

Listening- Listening to/ Viewing model interviews; **Speaking** –Speaking at different types of interviews – Role play practice (mock interview); **Reading** – Reading job advertisements and profile of the company concerned; **Writing**- job application – cover letter –Résumé preparation.

UNIT V REPORT WRITING 12

Listening- Viewing a model group discussion; **Speaking** –Participating in a discussion - Presentation; **Reading** – Case study - analyse -evaluate – arrive at a solution; **Writing**– Recommendations- Types of reports (feasibility report)- designing and reporting surveys- – Report format.- writing discursive essays.

TEACHING METHODS:

Practice writing
Conduct model and mock interview and group discussion.
Use of audio – visual aids to facilitate understanding of various forms of technical communication.
Interactive sessions.

EVALUATION PATTERN:

Internals – 50%
End Semester – 50%

TOTAL:60 PERIODS

OUTCOMES

- Students will learn the structure and organization of various forms of technical communication.
- Students will be able to listen and respond to technical content.
- Students will be able to use different forms of communication in their respective fields.

TEXTBOOK:

1. Craig,Thaine**. Cambridge Academic English: An integrated skills course for EAP(Student's Book)Level: Intermediate** Cambridge University Press, New Delhi: 2012

REFERENCES:

1. Laws, Anne. **Presentations.** Hyderabad: Orient Blackswan, 2011.
2. Ibbotson, Mark. **Cambridge English for Engineering**. Cambridge University Press, Cambridge,New Delhi: 2008
3. Naterop, Jean B. and Rod Revell. **Telephoning in English**. Cambridge: Cambridge University Press, 2004.
4. Rutherford, Andrea J. **Basic Communication Skills for Technology**. New Delhi: Pearson Education, 2001.
5. Bailey, Stephen. **Academic Writing A practical Guide for Students**. Routledge, London: 2004
6. Hewings, Martin**. Cambridge Academic English: An integrated skills course for EAP(Student's Book)Level: Intermediate** Cambridge University Press, New Delhi: 2012.

Attested

DIRECTOR
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Anna University, Chennai-600 025.

MA7251	MATHEMATICS - II (Common to all branches of B.E. / B.Tech. Programmes in II Semester)	L	T	P	C
		4	0	0	4

OBJECTIVES:

- To develop the use of matrix algebra techniques that is needed by engineers for practical applications.
- To acquaint the student with the concepts of vector calculus, needed for problems in all engineering disciplines.
- To develop an understanding of the standard techniques of complex variable theory so as to enable the student to apply them with confidence, in application areas such as heat conduction, elasticity, fluid dynamics and flow of the electric current.
- To make the student appreciate the purpose of using transforms to create a new domain in which it is easier to handle the problem that is being investigated.

UNIT I MATRICES **12**

Eigenvalues and Eigenvectors of a real matrix – Characteristic equation – Properties of eigenvalues and eigenvectors – Cayley-Hamilton theorem – Diagonalization of matrices – Reduction of a quadratic form to canonical form by orthogonal transformation – Nature of quadratic forms.

UNIT II VECTOR CALCULUS **12**

Gradient and directional derivative – Divergence and Curl – Irrotational and Solenoidal vector fields – Line integral over a plane curve – Surface integral - Area of a curved surface - Volume integral - Green's, Gauss divergence and Stoke's theorems – Verification and application in evaluating line, surface and volume integrals.

UNIT III ANALYTIC FUNCTION **12**

Analytic functions – Necessary and sufficient conditions for analyticity - Properties – Harmonic conjugates – Construction of analytic function - Conformal mapping – Mapping by functions $w = z + c$, az, $\frac{1}{z}$, z^2 - Bilinear transformation.

UNIT IV COMPLEX INTEGRATION **12**

Line integral - Cauchy's integral theorem – Cauchy's integral formula – Taylor's and Laurent's series – Singularities – Residues – Residue theorem – Application of residue theorem for evaluation of real integrals – Use of circular contour and semicircular contour with no pole on real axis.

UNIT V LAPLACE TRANSFORMS **12**

Existence conditions – Transforms of elementary functions – Transform of unit step function and unit impulse function – Basic properties – Shifting theorems -Transforms of derivatives and integrals – Initial and final value theorems – Inverse transforms – Convolution theorem – – Transform of periodic functions – Application to solution of linear ordinary differential equations with constant coefficients.

TOTAL: 60 PERIODS

OUTCOMES:

- Upon successful completion of the course, students should be able to:
- Evaluate real and complex integrals using the Cauchy integral formula and the residue theorem
- Appreciate how complex methods can be used to prove some important theoretical results.
- Evaluate line, surface and volume integrals in simple coordinate systems
- Calculate grad, div and curl in Cartesian and other simple coordinate systems, and establish identities connecting these quantities
- Use Gauss, Stokes and Greens theorems to simplify calculations of integrals and prove simple results.

TEXTBOOKS:

1. Erwin Kreyszig, "Advanced Engineering Mathematics", John Wiley and Sons, 9th Edition, New Delhi, 2014.
2. Grewal B.S., “Higher Engineering Mathematics”, Khanna Publishers, New Delhi, 43rd Edition, 2014.

REFERENCES:

1. Ramana, B.V. “Higher Engineering Mathematics”, Tata McGraw Hill, New Delhi, 2010.
2. Glyn James, “Advanced Modern Engineering Mathematics”, Pearson Education, New Delhi, 2007.
3. Jain R.K. and Iyengar S.R.K., “Advanced Engineering Mathematics”, Narosa Publications, New Delhi, 3rd Edition, 2007.
4. Bali N., Goyal M. and Watkins C., “Advanced Engineering Mathematics”, Firewall Media (An imprint of Lakshmi Publications Pvt., Ltd.,), New Delhi, 7th Edition, 2009.
5. Peter V. O’Neil , “Advanced Engineering Mathematics”, Cengage Learning India Pvt., Ltd, New Delhi, 2007.

CY7251	CHEMICAL REACTIONS DYNAMICS (Materials Science and Engineering)	L	T	P	C
		3	0	0	3

OBJECTIVES

- To study the solid state chemistry and kinetics.
- To understand the basic concept of adsorption isotherms.

UNIT I SOLID STATE CHEMISTRY 9

Solids – types-crystalline, amorphous and polycrystalline properties. Isotropy and anisotropy interfacial angles-symmetry in crystal systems-elements of symmetry, space lattice and unit cell, Bravias lattices-seven crystal systems. Types of bonds-molecular, covalent, metallic and ionic. Born-Haber cycle, lattice energy, imperfections in crystal-stoichiometric defects-Schottky, Frenkel. Non-stoichiometric defects-colour centre, F-centre.

UNIT II REACTION KINETICS IN SOLUTIONS 9

Determination of rate laws: Integral, Isolation, half-life and differential methods; comparison of different techniques. kinetic equations for complex reactions-chain, parallel, opposing and consecutive reactions; theory of reaction rates; temperature effect on reaction rates; rate constant for simple bimolecular reactions; collision theory; activated complex theory. Reactions in solutions: diffusion controlled and activation controlled reactions; thermodynamic formulation of rate constant: effect of pressure and ionic strength.

UNIT III REACTION KINETICS ON SURFACES 9

Adsorption: Adsorption of gases by solids-factors influencing adsorption. Langmuir adsorption; adsorption of solutes from solutions-Freundlich adsorption. applications-adsorption chromatography (column chromatography). Kinetics of surface catalyzed unimolecular and bimolecular reactions; Applications in ammonia synthesis and oxidation of carbon-monoxide.

UNIT IV KINETICS OF SOLID STATE REACTIONS 9

Solid State Reactions: types; sintering; nucleation; factors influencing the reactivity of solids; precursors to solid state reactions; Tammann and Hedvall mechanism; Wagner’s diffusion theory, material transport in solid state reaction-counter diffusion, Kirkendall effect; Huttig’s mechanism; kinetic model-reaction in powder compact, parabolic rate law, Jander’s rate equation. atomic theory of diffusion-self diffusion mechanism.

UNIT V PREPARATIVE METHODS 9

Vapour phase transport, preparation of thin films-electrochemical methods, chemical vapour deposition; crystal growth-Bridgman and Stokbarger methods, zone melting, high temperature ceramic methods, particle size reduction, precursor method, co-precipitation, sol-gel, microwave synthesis, combustion synthesis, high pressure methods, preparing single crystals- Czochralski, molecular beam epitaxy-temperature gradients, flame and plasma fusion, solution methods, Intercalation.

TOTAL: 45 PERIODS

OUTCOME

- Will know the solid state chemistry.
- Will know the preparative methods by various techniques.

TEXT BOOKS

1. K. J. Laidler, Chemical Kinetics, 4th Edn. Pearson Educations, New Delhi, 2007.
2. Sivasankar B., "Engineering Chemistry", Tata McGraw-Hill Publishing Company Ltd., New Delhi., 2012.

REFERENCES

1. M. J. Pilling and P. W. Seakins, "Reaction Kinetics" 1st Edn. Oxford University Press, London, 1995.
2. A. R. West, Solid State Chemistry and its Applications, 1st Edn. John Wiley, Singapore, 1998.
3. Sandra E. Dann, "Reactions and Characterization of Solids", 1st Edn.The Royal Society of Chemistry, Cambridge, 2000.
4. Leslie E. Smart and Elaine A. Moore "Solid State Chemistry: An Introduction", 3rd Edn.Taylor & Francis, New York, 2005.

CE7251 STRENGTH OF MATERIALS

L	T	P	C
3	0	0	3

OBJECTIVE:

- To understand the stresses developed in bars, compounds bars, beams, shafts, cylinders and spheres.

UNIT I STRESS, STRAIN AND DEFORMATION OF SOLIDS 9

Rigid bodies and deformable solids – Tension, Compression and Shear Stresses – Deformation of simple and compound bars – Thermal stresses – Elastic constants – Volumertric strains – Stresses on inclined planes – principal stresses and principal planes – Mohr's circle of stress.

UNIT II TRANSVERSE LOADING ON BEAMS AND STRESSES IN BEAM 9

Beams – types transverse loading on beams – Shear force and bending moment in beams – Cantilevers – Simply supported beams and over – hanging beams. Theory of simple bending – bending stress distribution – Load carrying capacity – Proportioning of sections – Flitched beams – Shear stress distribution.

UNIT III TORSION 9

Torsion formulation stresses and deformation in circular and hollows shafts – Stepped shafts – Deflection in shafts fixed at the both ends – Stresses in helical springs – Deflection of helical springs, carriage springs.

UNIT IV DEFLECTION OF BEAMS **9**

Double Integration method – Macaulay's method – Area moment Theorems for computation of slopes and deflections in beams - Conjugate beam and strain energy – Maxwell's reciprocal theorems.

UNIT V THIN CYLINDERS, SPHERES AND THICk CYLINDERS **9**

Stresses in thin cylindrical shell due to internal pressure circumferential and longitudinal stresses and deformation in thin cylinders – spherical shells subjected to internal pressure – Deformation in spherical shells – Lame's theory – Application of theories of failure.

TOTAL: 45 PERIODS

OUTCOMES:

- Upon completion of this course, the students can able to apply mathematical knowledge to calculate the deformation behavior of simple structures.
- Critically analyse problem and solve the problems related to mechanical elements and analyse the deformation behavior for different types of loads.

TEXT BOOkS:

1. Bansal, R.K., Strength of Materials, Laxmi Publications (P) Ltd., 2007
2. Jindal U.C., Strength of Materials, Asian Books Pvt. Ltd., New Delhi, 2007

REFERENCES:

1. Egor. P.Popov " Engineering Mechanics of Solids" Prentice Hall of India, New Delhi, 2001
2. Subramanian R., Strength of Materials, oxford University Press, Oxford Higher Education Series, 2007.
3. Hibbeler, R.C., Mechanics of Materials, Pearson Education, Low Price Edition, 2007
4. Ferdinand P. Been, Russell Johnson, J.r. and John J. Dewole Mechanics of Materials, Tata Mcgraw Hill publishing 'co. Ltd., New Delhi.

GE7151	COMPUTING TECHNIQUES	L	T	P	C
	(Common to all branches of Engineering and Technology)	**3**	**0**	**0**	**3**

OBJECTIVE

- To learn programming using a structured programming language.
- To provide C programming exposure.
- To introduce foundational concepts of computer programming to students of different branches of Engineering and Technology.

UNIT I INTRODUCTION **9**

Introduction to Computers – Computer Software – Computer Networks and Internet - Need for logical thinking – Problem formulation and development of simple programs - Pseudo code - Flow Chart and Algorithms.

UNIT II C PROGRAMMING BASICS **9**

Introduction to C programming – Fundamentals – Structure of a C program – Compilation and linking processes - Constants, Variables – Data Types – Expressions - Operators –Decision Making and Branching – Looping statements – Solving Simple Scientific and Statistical Problems.

UNIT III ARRAYS AND STRINGS **9**

Arrays – Initialization – Declaration – One dimensional and two dimensional arrays - Strings- String operations – String Arrays - simple programs- sorting- searching – matrix operations.

UNIT IV POINTERS **9**

Macros - Storage classes –Basic concepts of Pointers– Pointer arithmetic - Example Problems - Basic file operations

UNIT V FUNCTIONS AND USER DEFINED DATA TYPES **9**

Function – definition of function – Declaration of function – Pass by value – Pass by reference – Recursion –Enumerators – Structures - Unions

TOTAL : 45 PERIODS

OUTCOME

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

- Write C program for simple applications
- Formulate algorithm for simple problems
- Analyze different data types and arrays
- Perform simple search and sort**.**
- Use programming language to solve problems.

TEXTBOOKS:

1. Pradip Dey, Manas Ghosh, “Computer Fundamentals and Programming in C”, Second Edition, Oxford University Press, 2013
2. Ashok N. Kamthane, “Computer programming”, Pearson Education, 2007.
3. Yashavant P. Kanetkar. “Let Us C”, BPB Publications, 2011.

REFERENCES:

1. Kernighan,B.W and Ritchie,D.M, “The C Programming language”, Second Edition, Pearson Education, 2006
2. Byron S Gottfried, “Programming with C”, Schaums Outlines, Second Edition, Tata McGraw-Hill, 2006.
3. R.G. Dromey, “How to Solve it by Computer”, Pearson Education, Fourth Reprint, 2007

CE7261 STRENGTH OF MATERIALS LABORATORY **L T P C**

0 0 4 2

OBJECTIVES

- To study the properties of materials when subjected to different types of loading.

LIST OF EXPERIMENTS

1. Tension test on mild steel rod
2. Double shear test on metal
3. Torsion test on mild steel rod
4. Impact test on metal specimen (Izod and Charpy)
5. Hardness test on metals (Rockwell and Brinell Hardness Tests)
6. Deflection test on metal beam
7. Compression test on helical spring
8. Deflection test on carriage spring

TOTAL: 60 PERIODS

OUTCOMES

- Ability to perform different destructive testing
- Ability to characteristic materials

REFERENCE:

1. Relevant Indian Standards

GE7161 COMPUTER PRACTICES LABORATORY

L	T	P	C
0	0	4	2

OBJECTIVES

- To understand the basic programming constructs and articulate how they are used to develop a program with a desired runtime execution flow.
- To articulate where computer programs fit in the provision of computer-based solutions to real world problems.
- To learn to use user defined data structures.

LIST OF EXPERIMENTS

1. Search, generate, manipulate data using MS office/ Open Office
2. Presentation and Visualization – graphs, charts, 2D, 3D
3. Problem formulation, Problem Solving and Flowcharts
4. C Programming using Simple statements and expressions
5. Scientific problem solving using decision making and looping.
6. Simple programming for one dimensional and two dimensional arrays.
7. Solving problems using String functions
8. Programs with user defined functions
9. Program using Recursive Function
10. Program using structures and unions.

TOTAL: 60 PERIODS

OUTCOMES

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

- Write and compile programs using C programs.
- Write program with the concept of Structured Programming
- Identify suitable data structure for solving a problem
- Demonstrate the use of conditional statement.

LABORATORY REQUIREMENTS FOR BATCH OF 30 STUDENTS

30 Systems with C compiler

CY7302 POLYMER SCIENCE AND ENGINEERING

L	T	P	C
3	0	0	3

OBJECTIVE

- The subject exposes students to the basics of polymer, polymerisation, condensation, their properties and overview of manufacturing.

UNIT I INTRODUCTION TO POLYMERS 9

Fundamentals of polymers - monomer - functionality - Classification - polymerization - its types and techniques - Structure, property and applications of polyethylene, polypropylene, polyvinyl chloride, polystyrene, Polymethyl methacrylate, PTFE, polyamides, polyesters, polycarbonates and polyurethanes - copolymers - interfacial polymerization and cross linked polymers

UNIT II MOLECULAR WEIGHTS OF POLYMERS 9

Number average and weight average molecular weights – degree of polymerization – molecular weight distribution – polydispersity – molecular weight determination- different methods – Gel Permeation Chromatography.

UNIT III TRANSITIONS IN POLYMERS 9

First and second order transitions – glass transition, Tg – multiple transitions in polymers – experimental study – significance of transition temperatures. Crystallinity in polymers – effect of crystallization – factors affecting crystallization, crystal nucleation and growth – relationship between Tg and Tm – structure–property relationship.

UNIT IV SOLUTION PROPERTIES OF POLYMERS 9

Size and shape of the macromolecules – solubility parameter – polymer/solvent interaction parameter – temperature – size and molecular weight. Solution properties of polymers. Importance of rheology – Newtonian and non-Newtonian flow behavior –polymer melts rheology.

UNIT V POLYMER PROCESSING 9

Overview of features of single screw extruder –tubular blown film process –co-extrusion.- Injection moulding systems –compression & transfer moulding - blow moulding – rotational moulding – thermoforming – vacuum forming - calendaring process – fiber spinning process – structural foam moulding – sandwich moulding. Processing for thermosets- reaction injection moulding &reinforced reaction injection moulding.

TOTAL: 45 PERIODS

OUTCOME

- Use of techniques for polymer processing.
- Ability to develop structure – property relationship in polymer.

TEXTBOOKS

1. V.R. Gowariker, N.V. Viswanathan and Jayadev Sreedhar, “Polymer Science” New Age International (p) Ltd., New Delhi (2010).
2. F.W. Bill Mayer, “Text book of polymer science” 3rd Edition – John Wiley & sons, Inc., New York (2011).

REFERENCES

1. George Odian “Principles of polymerization”, 4th Edition – John Wiley & sons, Inc., New York (2004).
2. J.A. Brydson, “Plastic Materials”, Heinemenn / Elsevier Publisher,7th edition,2005
3. Krzysztof Matyjaszenski, “Hand Book of Radical Polymerisation”,-Wiley, John & Sons. (2003).
4. G.S.Misra, “Introductory Polymer Chemistry ”New age International Publishers, India (2005)
5. M.S.Bhatnagar, “ A Textbook of Polymers, Volume 1: Chemistry and Technology of Polymers (Basic Concepts), S. Chand & Company Ltd. (2010).
6. R.J. Crawford, “Plastics Engineering” Third Edition, Butterworth-Heinmann Publication, (1998).
7. Joel.R.Fried, “Polymer science and technology”, Prentice Hall; 3rd edition (2014)
8. P.J. Flory, “Principles of Polymer Chemistry” Cormell Univ. Press (1953).

MA7352 **APPLIED STATISTICS** **L T P C**
4 0 0 4

OBJECTIVE

- The students will have a fundamental knowledge of the concepts of statistical inference and apply the tools in management problems.

UNIT I TESTS OF SIGNIFICANCE **12**

Sampling distributions – Central limit theorem-Tests for single mean, proportion and difference of means, proportions (large and small samples) - Tests for single variance and equality of variances- χ^2 - test for goodness of fit - Independence of attributes.

UNIT II NON - PARAMETRIC TESTS **12**

Advantages and drawbacks over parametric methods – Sign test - Median test – Mann-Whitney Wilcoxon U-test – Wald-Wolfowitz run test.

UNIT III DESIGN OF EXPERIMENTS **12**

Completely randomized design - Randomized block design - Latin square design - 2^2 factorial design - Taguchi's robust parameter design.

UNIT IV STATISTICAL QUALITY CONTROL **12**

Control charts for variables - Control charts for attributes - Tolerance limits - Acceptance sampling by attributes.

UNIT V TIME SERIES **12**

Components of time series - Analysis of time series - Measurement of trend - Measurement of seasonal fluctuations.

TOTAL: 60 PERIODS

OUTCOME

- The students can independently participate in the processes of analysis, planning, formulating strategies of development, decision-making, governing and management, and independent making of tactical and strategic decisions related to the statistics.

TEXTBOOKS

1. Walpole R.E., Myers R.H., Myers S.L. and Keying Ye, "Probability and Statistics for Engineers and Scientists", Pearson Education, Asia, 8th Edition 2007.
2. Gupta S.C. and Kapoor V.K., "Fundamentals of Applied Statistics", Sultan Chand and Sons, New Delhi, 2nd Edition, Reprint, 2002.

REFERENCES

1. Johnson R.A., "Miller and Freund's Probability and Statistics for Engineers", PHI Learning Pvt. Ltd., New Delhi, 8th Edition, 2011.
2. Devore, J.L., "Probability and Statistics for Engineering and the Sciences", Thomson Brooks/Cole, International Student Edition, New Delhi, 7th Edition, 2008.
3. Milton, J. S. and Arnold, J.C., "Introduction to Probability and Statistics", Tata McGraw Hill, New Delhi, 4th Edition, 3rd Rep

ML7301 CASTING AND MACHINING PROCESSES L T P C
3 0 0 3

OBJECTIVE

- To impart knowledge on the various foundry practices and secondary machining operations carried out In the Industry.

UNIT I PATTERN AND DIE MAKING 9

Introduction to foundry process flow, Patterns – types, functions, allowances, Selection of pattern materials, colour codes, core boxes, - considerations in Core box manufacturing, Die materials, Die design and manufacturing techniques Computer applications in Pattern and Die making.

UNIT II CASTING DESIGN 9

Solidification of pure metals and alloys –shrinkage in cast metals – Design of Sprue, runner, gates –problems in design and manufacture of thin and unequal Sections, designing for directional solidification, Riser design-Chvorinov's rule, Caines, Modulus , Naval Research Laboratory methods, feeding distances – Calculations and number of Risers required, chills and feeding aids – Exothermic And Insulating sleeves Design problems of L, T, V, X and Y junctions, Computer Applications in casting design—Software for casting design

UNIT III MOULDING AND CASTING PRACTICES 9

Sand for foundry applications – types, properties, tests. Moulding and Cores and Ingredients, Moulding and Core sand preparations, testing. Various Moulding Practices – Green Sand, CO_2 process, No Bake, Shell, Investment Casting, Permanent Moulding – Gravity, Low Pressure, High Pressure Die casting processes, Ceramic, Plaster of Paris, Centrifugal, Squeeze, Electro Magnetic and Lost Foam processes.

UNIT IV MELTING AND POURING PRACTICES 9

Principles of melting practice – Fluxing, Degasification, Modification, Deoxidation and Inoculation, Types of furnaces –Crucibles, Cupola, Oil fired furnaces, Electric furnaces – Arc and Induction types, Melting practices of Cast Iron, SG Iron, Carbon Steels, High alloy and Stainless steels, Aluminium and Copper alloys, Melt Quality control in all above processes.

UNIT V MACHINING 9

Metal cutting- chip formation, types of chips, principles of cutting –Tool Wear and failure. Principles of Turning, Drilling, Tapping, Milling, Planing, Shaping and Broaching operations – Gear manufacturing.

TOTAL: 45 PERIODS

OUTCOMES

- Ability to understand and perform basic casting processes.
- Ability to design casting and select suitable casting process for different materials.
- Ability to perform basic machining operations in the cast components.

TEXT BOOKS

1. R.W.Heine, R.Loper, P.C.Rosenthal, "Principles of Metal Casting", 2nd edition Tata-McGraw Hill.
2. P.L. Jain, "Principles of Foundry Technology", Tata-McGraw Hill, 2003.

REFERENCES

1. R.K.Jain, S.C.Gupta, "Production Technology", Khanna publishers, New Delhi. Year of pub
2. AFS Foundry Sand Handbook, American Foundrymen's Society, Desplaines, 1963.
3. AFS Pattern Maker's Manual-American Foundrymen's Society, Desplaines, 1960

4. ASM Casting Design Handbook, American Society of Metals, Metals Park, 1962.
5. Chvorinov N, Geisserei, “Theory of Solidification of castings”, , Vol.27, 1940, pp 177- 225.
6. N.N. Zorev, “Metal Cutting mechanics”, Pergamon Press, Oxford, 1965.

ML7302 ELECTRICAL AND ELECTRONIC PROPERTIES OF MATERIALS

L	T	P	C
3	0	0	3

OBJECTIVE

- To equip the students to have a knowledge on different types of electron theory, basics of quantum mechanics and about energy bands
- To introduce the physics of semiconducting materials and applications of semiconductors in device fabrication
- To make the students to learn the mechanisms of polarization in dielectric materials, and about classification and properties of dielectric materials
- To make the students to learn the origin of magnetism in magnetic materials and their classification; to learn the physics of superconductivity and various properties exhibited by superconductors
- To make the students familiarize with the optical properties of materials.

UNIT I ELECTRICAL PROPERTIES OF MATERIALS 9

Classical free electron theory - Expression for electrical conductivity – Thermal conductivity, expression - Wiedemann-Franz law – Success and failures - Quantum free electron theory – Particle in a finite potential well – Tunneling- Particle in a three dimensional box – degenerate states – Fermi- Dirac statistics – Density of energy states – Electron in periodic potential – Energy bands in solids – tight binding approximation - Electron effective mass – concept of hole.

UNIT II SEMICONDUCTOR PHYSICS 9

Intrinsic Semiconductors – Energy band diagram – direct and indirect band gap semiconductors – Carrier concentration in intrinsic semiconductors – extrinsic semiconductors - Carrier concentration in N-type & P-type semiconductors – Variation of carrier concentration with temperature – Carrier transport in Semiconductors: Drift, mobility and diffusion – Hall effect and devices – Ohmic contacts – Schottky diode.

UNIT III DIELECTRICS AND FERROELECTRICS 9

Macroscopic description of the static dielectric constant. The electronic and ionic polarizabilities of molecules - orientational polarization - Measurement of the dielectric constant of a solid. The internal field - Lorentz, Clausius-Mosotti relation. Behaviour of dielectrics in an alternating field, elementary ideas on dipole relaxation, - Piezo, pyro and ferroelectric properties of crystals - classification of ferroelectric crystals - $BaTiO_3$ and KDP.

UNIT IV MAGNETISM AND SUPERCONDUCTIVITY 9

Atomic magnetic moment – classification of magnetic materials: diamagnetism, paramagnetism, ferromagnetism, antiferromagnetism and ferrimagnetism - Ferromagnetism: saturation magnetization and Curie temperature – exchange interaction - Domain theory – M versus H behavior – soft and hard magnetic materials -. Superconductivity – Zero resistance and the Meissner effect – Type I and Type II superconductors – critical current density - BCS theory of superconductivity - Elements of high temperature superconductivity (basic concepts only).

UNIT V OPTICAL PROPERTIES OF MATERIALS 9

Light waves in a homogeneous medium - refractive index - dispersion: refractive index-wave-length behaviour - group velocity and group index – NLO materials – phase matching - SHG, sum

frequency generation, parametric oscillations – difference frequency generation (qualitative)- applications- - complex refractive index and light absorption - Luminescence, phosphors and white LEDs - polarization - optical anisotropy: uniaxial crystals, birefringence, dichroism - electro-optic effect and amplitude modulators.

TOTAL: 45 PERIODS

OUTCOME

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

- familiarize with theories of electrical and thermal conduction is solids, basic quantum mechanics, and energy bands
- gain knowledge on semiconducting materials based on energy level diagrams, its types, temperature effect.
- understand the mechanisms of various types of polarization and about classification and properties of ferroelectric crystals
- to learn the classification of magnetic materials, theory and applications of ferromagnetic materials and superconductors
- acquire knowledge on light waves, non-linear optical properties of materials and their applications

TEXTBOOKS

1. Palanisamy, P.K., “Materials Science”, Scitech (2013).
2. Pillai, S.O. “Solid State Physics”, New Age International (2014).
3. Balasubramaniam, R. “Callister's Materials Science and Engineering” Wiley India Pvt. Ltd. (2014).
4. Donald Askeland, “Materials Science and Engineering”, Cengage Learning India Pvt Ltd (2010).

REFERENCES

1. Kasap, S.O., “Principles of Electronic Materials and Devices”, Tata McGraw-Hill (2007).
2. Kittel, C., “Introduction to Solid State Physics”, Wiley; Eighth edition (2012).
3. Ajoy Kumar Ghatak and K. Thyagarajan, “Optical electronics”, Cambridge University Press, New Delhi (2013).

ML7303 METALLURGICAL THERMODYNAMICS

L	T	P	C
3	0	0	3

OBJECTIVE

- To introduce the basic knowledge of thermodynamics required for understanding various alloy systems, phase transformations and interpreting properties

UNIT I FUNDAMENTAL CONCEPTS 6

Definition of thermodynamic terms; concept of states, systems, equilibrium. Equation of states, extensive and intensive properties, homogeneous and heterogeneous systems. Phase diagrams, Internal energy, heat capacity, enthalpy, isothermal, and adiabatic processes.

UNIT II INTERNAL ENERGY AND ENTROPY 9

First law of Thermodynamics: Relation between Heat and work, Internal energy, Enthalpy. The Second law of thermodynamics: Spontaneous process, Degree of measure of reversibility and irreversibility, Maximum work, criteria of equilibrium. Combined statement of first and second laws on thermodynamics. Statistical interpretation of entropy: Concept of microstate, most probable microstate, Thermal equilibrium, Boltzman equation

UNIT III AUXILLARY FUNCTIONS AND THERMODYNAMIC POTENTIALS 10

Auxiliary functions: Helmholtz, Gibbs free energy, Maxwell's equation, Gibbs-Helmholtz equations. Concept of Third law, temperature dependence of entropy, dry and Einstein concept of heat capacity, relation between Cp and Cv, Consequences of third law. Zeroth law of thermodynamics and its applications. Thermodynamic potentials: Fugacity, Activity and Equilibrium constant. Clausius - Clayperon equation. Le Chatelier's principle, Vant Hoff's equation.

UNIT IV THERMODYNAMICS OF SOLUTIONS 10

Solutions, partial molar quantities, ideal and non-ideal solutions, Henry's law, Gibbs - Duhem equation, regular solution, quasi-chemical approach to solution, statistical treatment. Change of standard state. Phase relations and phase rule-its applications. Free energy composition diagrams for binary alloy systems, determination of liquidus, solidus and solvus lines. Effect of pressure on phase transformation and phase equilibria.

UNIT V THERMODYNAMICS OF REACTIONS 10

Thermodynamics of electrochemical cells, solid electrolytes. Pourbaix diagrams. Thermodynamics of Surfaces: Adsorption isotherms, Effect of surface energy on pressure and phase transformation temperature. Thermodynamics of Defects in solids: Point defects, vacancies and interstitials in solid metals.

TOTAL: 45 PERIODS

OUTCOME

- A fundamental understanding of the first and second laws of thermodynamics and their application to a wide range of system.
- The student should be able to use thermodynamics on solid state equilibrium as well as on equilibrium between solids and gases

TEXTBOOKS

1. David R Gaskell, "Introduction to the Thermodynamics of materials", Taylor and Francis, Fifth edition, 2008.
2. Boris.S.Bokstein, Mikhail I. Mendelev, David J. Srolovitz," Thermodynamics and Kinetics in Materials science", Oxford University Press 2005.

REFERENCES

1. Prasad, Krishna Kant, Ray, H. S. and Abraham, K. P., "Chemical and Metallurgical Thermodynamics", New Age International, 2006.
2. Upadhyaya, G. S. and Dube, R. K., "Problems in Metallurgical Thermodynamics and Kinetics", Pergamon Press, London, 1977.
3. J J Moore, "Chemical Metallurgy", Butterworth-Heinemann Ltd, 1990.
4. Thomas Engel, Philip Reid, Thermodynamics, Statistical Thermodynamics and Kinetics, Pearson Education (LPE) 2007.
5. Ahindra Ghosh, Textbook of Materials and Metallurgical Thermodynamics, Prentice hall of India, 2003.
6. Darken LS and Gurry R W ,"Physical Chemistry of Metals", McGraw Hill, 1987.
7. Swalin R A, "Thermodynamics of solids", John Wiley Sons Inc, third edition, 1966.
8. David V Ragone, "Thermodynamics of Materials - Volume-1", John Wiley & Sons, Inc. 1995.
9. Peter Atkins, Julio de Paula, Physical Chemistry Volume 1: Thermodynamics and Kinetics, W. H. Freeman & Company, 2010
10. DeHoff R T, Thermodynamics in Materials science, McGrawhill, Newyork 1993.

ML7304 STRUCTURE AND PROPERTIES OF MATERIALS

L	T	P	C
3	0	0	3

OBJECTIVE

- The subject introduces the correlation of properties of materials and their structure. It revises student's knowledge of crystal structure and phase diagrams of various alloy systems. The course covers the structure and properties of ferrous and non-ferrous alloys, ceramics, polymers, elastomers and composite materials.

UNIT I STRUCTURE OF SOLIDS 9

Overview of Crystal Structure – Solid Solutions-Hume Rothery Rules-Crystal Imperfections-Point Defects- Line Defects-Surface Defects-Bulk Defects-Critical nucleus size and Critical Free energy-Mechanism of Crystallization- Nucleation-Homogeneous and Heterogeneous Nucleation- Growth - Single crystal -Polycrystalline Materials - Basic principles of solidification of metals and alloys. Growth of crystals- Planar growth – dendritic growth – Solidification time- Cooling curves - Non-crystalline solids- Glass Transition Temperature.

UNIT II PHASE DIAGRAMS 9

Phase Rule –Unary System- Binary Phase diagrams- Isomorphous systems-Congruent phase diagrams - Free energy Composition curves- Construction -Microstructural changes during cooling- Tie Line- Lever Rule- Eutectic , Peritectic, Eutectoid and Peritectoid reactions-Typical Phase diagrams – Cu-Zn System – Pb-Sn system- Ag-Pt system-Iron-Iron carbide Equilibrium Diagram.

UNIT III FERROUS AND NON-FERROUS MATERIALS 9

Classification of steels and cast iron –Microstructure– Effect of alloying elements on steel- Ferrous alloys and their applications - Factors affecting conductivity of a metal – Electrical Resistivity in alloys – Thermal conductivity of metals and alloys - High Resistivity alloys –Some important Titanium alloys, Nickel alloys, Copper alloys, Magnesium alloys and Aluminium alloys.

UNIT IV CERAMIC AND COMPOSITE MATERIALS 9

Types - Crystal Structures - Silicate Ceramics - Glasses – Glass Ceramics – Advanced Ceramics-Functional properties and applications of ceramic materials – Super hard materials- Tungsten carbide and Boron nitrides – Graphene.

Classification of Composites - Fibre reinforced materials – Law of mixtures – Continuous fibres– Discontinuous fibres – Particle-reinforced composites – Cermets – Dispersion strengthened materials – Structural composites- Laminar – Sandwich panel-Application of composites in various fields of technology-Smart Composites

UNIT V POLYMERS AND ELASTOMERS 9

Classification of polymer – Mechanisms of polymerisation – Copolymers – Examples- Defects in polymers- Thermoplastics - Thermosets – Engineering plastics - Advanced Polymeric materials - Liquid crystal polymers - Conductive polymers – High Performance fibres– Photonic polymers- - Elastomers- Applications

TOTAL: 45 PERIODS

OUTCOMES

- Recognise basic nomenclature, basic microstructure, and associate terms with the appropriate structure / phenomena and be able to differentiate between related structure / phenomena.
- Perform simple calculations to qualify materials properties and microstructural characteristics.
- Recognise the effect of composition and microstructure on material properties.
- Ability to perform phase equilibrium calculation and construct phase diagram.
- Select suitable ferrous and non-ferrous materials for engineering application.

TEXT BOOKS

1. William D. Callister, Jr., "Materials Science and Engineering an Introduction", 2/e Edition,John Wiley & Sons, Inc., 2007.
2. V. Raghavan, "Materials Science and Engineering", Prentice –Hall of India Pvt. Ltd., 2007

REFERENCES

1. Sidney H. Avner, “Introduction to Physical Metallurgy”, Tata Mc-Graw-Hill Inc,2/e, 1997.
2. Vijendra Singh, “Physical Metallurgy”, Standard Publishers Distributors, New Delhi,2012.
3. Kingery, W. D., Bowen H. K. and Uhlmann, D. R., “Introduction to Ceramics”, 2nd Edition, John Wiley & Sons, New York, 1976.
4. Donald R. Askeland, Pradeep P. Phule, “The Science and Engineering of Materials”, 5th Edition, Thomson Learning, First Indian Reprint, 2007.
5. William F. Smith, “Structure and Properties of Engineering Alloys”, Mc-Graw-Hill Inc.,U.S.A, 2nd edition, 1993.
6. F. N. Billmayer, “Test Book of polymer science”, John Wiley & Sons, New York, 1994.

ML7311	FOUNDRY AND MACHINING LABORATORY	L	T	P	C
		0	0	4	2

OBJECTIVE

- To make students learn about melting of metals, casting of metals and various sand testing methods.
- To practice basic machining operations which can be carried out in general purpose and Special Purpose Machine Tools.

LIST OF EXPERIMENTS-FOUNDRY

1. Determination of Average Sand grain Fineness.
2. Determination of Moisture content in Sand
3. Determination of Permeability of Green Sand
4. Estimation of Active clay content in Sand
5. Loss on Ignition Test for Green moulding Sand
6. Determination of Green Compression and Shear Strength.
7. Determination of Dry Compression Strength.
8. Determination of Scratch Hardness.
9. Determination of Compatibility.
10. Metal Casting by Green sand and full mould process.

LIST OF EXPERIMENTS-MACHINING

1. Machining practice in lathe: Taper Turning,
2. Drilling and Tapping
3. Machining practice in Grinding: Cylindrical, Surface, Tool and Cutter Grinding
4. Spur and helical gear cutting in Milling Machine.
5. Demonstration on CNC drilling

TOTAL: 60 PERIODS

OUTCOME

- This course will enable the student to know typical process of foundry covering melting of various metals, sand mould preparation and also the different testing methods.
- The student will gain knowledge on various machining operations and will have some hands on experience in machining operations like work piece mounting, tool selection, operating conditions for a process and cross check the dimensions of the machined component

ML7312 MICROSTRUCTURAL ANALYSIS LABORATORY L T P C
0 0 4 2

OBJECTIVE

- To gain knowledge on the microstructures of some common types of metals and alloys and to perform the grain size analysis of the given samples.

LIST OF EXPERIMENTS

1. Study of metallurgical microscope and sample preparation.
2. Quantitative Metallography – Grain Size, Nodule count, Amount of Phases.
3. Macro etching - cast, forged and welded components.
4. Microscopic examination of cast irons - Gray, White, Malleable and Nodular types
5. Microscopic examination of Plain carbon steels (low carbon, medium carbon, high carbon steels).
6. Microscopic examination of Austenitic Stainless steels and High Speed Steels.
7. Microscopic examination of banded structure in steels and welded joints.
8. Microscopic examination of Copper alloys
9. Microscopic examination of Aluminium alloys
10. Microscopic examination of Titanium alloys

TOTAL: 60 PERIODS

OUTCOME

- The student will acquire knowledge on the microstructural analysis of various metals and alloys with regard to sample preparation via polishing and etching and use and analysis of optical microscopy

ME7353 MECHANICS OF MACHINES L T P C
3 0 0 3

OBJECTIVE

- To understand the principles in the formation of mechanisms and their kinematics.
- To understand the effect of friction in different machine elements.
- To analyze the forces and torque acting on simple mechanical systems
- To understand the importance of balancing and vibration.

UNIT I KINEMATICS OF MECHANISMS 9

Mechanisms – Terminology and definitions – kinematics inversions of 4 bar and slide crank chain – kinematics analysis in simple mechanisms – velocity and acceleration polygons– Analytical methods – computer approach – cams – classifications – displacement diagrams - layout of plate cam profiles – derivatives of followers motion – circular arc and tangent cams.

UNIT II GEARS AND GEAR TRAINS 9

Spur gear – law of toothed gearing – involute gearing – Interchangeable gears – Gear tooth action interference and undercutting – nonstandard teeth – gear trains – parallel axis gears trains – epicyclic gear trains – automotive transmission gear trains.

UNIT III FRICTION IN MACHINE ELEMENTS 9

Surface contacts – Sliding and Rolling friction – Friction drives – Friction in screw threads – Bearings and lubrication – Friction clutches – Belt and rope drives – Friction aspects in brakes– Friction in vehicle propulsion and braking.

UNIT IV FORCE ANALYSIS 9

Applied and Constrained Forces – Free body diagrams – static Equilibrium conditions – Two, Three and four members – Static Force analysis in simple machine members – Dynamic Force Analysis – Inertia Forces and Inertia Torque – D'Alembert's principle – superposition principle – dynamic Force Analysis in simple machine members

UNIT V BALANCING AND VIBRATION 9

Static and Dynamic balancing – Balancing of revolving and reciprocating masses – Balancing machines – free vibrations – Equations of motion – natural Frequency – Damped Vibration – bending critical speed of simple shaft – Torsional vibration – Forced vibration – harmonic Forcing – Vibration isolation.

TOTAL: 45 PERIODS

OUTCOME

- The course will enable the student to understand the forces and torque acting on simple mechanical systems and also the importance of balancing and vibration and the effect of friction in different machine parts of practical significance.

TEXTBOOK

- Uicker, J.J., Pennock G.R and Shigley, J.E., "Theory of Machines and Mechanisms" , 3rdEdition, Oxford University Press, 2009.

REFERENCES

1. Rattan, S.S, "Theory of Machines", 3rd Edition, Tata McGraw-Hill, 2009.
2. Thomas Bevan, 'Theory of Machines', 3rd Edition, CBS Publishers and Distributors,2005.
3. Cleghorn. W. L, "Mechanisms of Machines", Oxford University Press, 2005
4. Benson H. Tongue, "Principles of Vibrations", Oxford University Press, 2nd Edition,2007
5. Robert L. Norton, Kinematics and Dynamics of Machinery, Tata McGraw-Hill, 2009.
6. Ghosh. A and Mallick, A.K., "Theory of Mechanisms and Machines', Affiliated East-West Pvt. Ltd., New Delhi, 1988.
7. Rao.J.S. and Dukkipati.R.V. 'Mechanisms and Machine Theory', Wiley-Eastern Ltd., New Delhi, 1992.
8. John Hannah and Stephens R.C., 'Mechanics of Machines', Viva Low-Prices Student Edition, 1999.
9. Grover. G.T., "Mechanical Vibrations", Nem Chand and Bros., 1996
10. William T. Thomson, Marie Dillon Dahleh, Chandramouli Padmanabhan, "Theory of Vibration with Application", 5th edition Pearson Education, 2011
11. V.Ramamurthi, Mechanics of Machines, Narosa Publishing House, 2002.
12. Allen S. Hall Jr., "Kinematics and Linkage Design", Prentice Hall, 1961

ML7401 CHARACTERISATION OF MATERIALS - I L T P C
3 0 0 3

OBJECTIVE

- To have thorough understanding of theory, instrumentation and applications of analytical equipments used for chemical analysis.

UNIT I INTRODUCTION TO SPECTRAL METHODS 9

Molecular and atomic spectroscopy-interaction of electromagnetic radiation with matter- Energy levels in atoms and molecules – Absorption techniques and emission techniques: fluorescence, phosphorescence and chemiluminescence – Beer-Lambert law; qualitative and quantitative analyses – limitations – visible absorption spectroscopy.

UNIT II UV AND VISIBLE SPECTROCOPY 9

Electronic transitions and energy level diagrams, Choice of solvents, cut off wavelengths for solvents, Woodward –Fieser rules for the calculation of absorption maxima, Effects of conjugation and solvent polarity on the absorption maxima. Instrumentation for UV and Visible spectrophotometers - source, optical parts and detectors. Photometric titration - experimental setup and various types of titrations and their corresponding curves. Applications of UV and Visible spectrophotometry.

UNIT III IR , RAMAN AND ATOMIC SPECTROSCOPY 9

Theory of IR spectroscopy, Various stretching and vibration modes for diatomic and triatomic molecules (both linear and nonlinear), various ranges of IR and their usefulness, Instrumentation (sources, optical path and detectors used in different regions), sample preparation techniques, Applications. Raman spectroscopy: Theory, Differences between IR and Raman. Atomic absorption spectrophotometry: Principle, Instrumentation, types of fuels, Hollow cathode lamp, detector and applications, Flame photometry: Principle, Instrumentation and applications in quantitative analysis – ICP-AES: Instrumentation and applications

UNIT IV SEPARATION TECHNIQUES 9

Solvent extraction and ion exchange techniques –principles and applications; Chromatographic techniques – adsorption chromatography, thin layer chromatography, gas chromatography, high performance chromatography. Separation of organic compounds by column and thin layer and paper chromatographic techniques. Qualitative and quantitative analyses by GC and HPLC.

UNIT V THERMAL AND SURFACE ANALYTICAL METHODS 9

Thermal analytical techniques- TGA, DTA, DSC – principles, instrumentation and applications; Surface analysis – TEM, SEM and AFM – Principles, instrumentation and applications.

TOTAL: 45 PERIODS

OUTCOME

- This subject familiarize the students about the principle and working of various sophisticated instruments (FTIR, UV vis, Raman, AAS, Flame photometry, ICP-AES, HPLC, GC, TGA,DSC and DTA; TEM, SEM and AFM) and their use in material analysis.

TEXTBOOKS

1. D. A. Skoog, F. James Leary and T. A. Nieman, “Principles of Instrumental Analysis”, Fifth Edition, Saunders Publishing Co., 1998
2. D.A. Skoog, F.J. Holler and S.R. Crouch, “Principles of Instrumental Analysis” 6th Edition, Thomas Brookes/Cole, 2007

REFERENCES

1. Willard, H.H., Merritt.l.l., Dean J.a., and Settle,F.A., Instrumental methods of analysis,Sixth edition, CBS publishers,1986.
2. F.W. Fifield and D. Kealey, “Principles and Practice of Analytical Chemistry, 1st Indian Reprint, Blackwell Pub., 2004.
3. J. Mendham, R.C. Denney, J.D. Barnes, M. Thomas and B. Sivasankar., “Vogel’s Text Book of Quantitative chemical analysis” , 6th Edition, Pearson, 2009.
4. Day R.A Underwood A.L Qualitative Inorganic analysis (A. I. Vogel). V Edition, Prentice- Hall of India (P) Ltd, NewDelhi
5. G.D Christian, “ Analytical Chemistry” , 6th Edn., John Wiley Press (2006).
6. Sharma, B.K., Instrumental Methods of Analysis, Goel publishing House,1995
7. Kalsi .P.S. Spectroscopy of organic compounds, 6th Edition, New Age International Publishers,2006
8. William Kemp, Organic Spectroscopy, 3rd Edition, Palgrave publishers, 2007

ML7402 HEAT TREATMENT OF METALS AND ALLOYS

L	T	P	C
3	0	0	3

OBJECTIVE

- The course covers the fundamental aspects of the theory and practice of heat treatment of metals and alloys. It provides a comprehensive understanding of the various transformation reactions associated with the changes in microstructures and properties that occur due to controlled heat treatment.

UNIT I TRANSFORMATIONS IN STEELS 9

Allotropic changes in Iron, Iron-Iron carbide equilibrium diagram – transformations on heating and cooling - influence of alloying elements – general principles of heat treatment of steels – isothermal and continuous cooling transformations in steels – Time-Temperature-Transformation curves (TTT-diagrams), continuous cooling transformations – CCT-diagrams– effect of alloying additions on TTT diagrams, mechanism and kinetics of pearlitic, bainitic and martensitic transformations – habit plane – Bain distortion model

UNIT II HEAT TREATMENT PROCESSES 9

Annealing- Types, Normalising, Hardening & Quenching –Mechanisms-hardenability studies– Jominy end-quench test, Grossman's experiments, tempering – Hollomon& Jaffe tempering correlations, tempering – tempered brittleness – effects of alloying elements on tempering, austempering and martempering, precipitation hardening, thermo-mechanical treatment, intercritical heat treatment, polymer quenching, sub-zero treatment – cryogenic quenching, patenting

UNIT III CASE HARDENING 9

Introduction, carburisation – principle – carbon potential – mechanism – application of Fick's law– depth of carburisation and its control – methods of carburising – heat treatment after carburizing – structure, properties and defects in carburising, nitriding – mechanism – retained austenite – Remedy- effect of microstructure – nitriding methods, ion-nitriding and nitro-carburising, boronising, chromising, cyaniding and carbonitriding, induction and flame hardening, Laser and Electron beam welding – principles – methods – operating variables, measurement of case depth.

UNIT IV FURNACES, ATMOSPHERE AND PROCESS CONTROL 9

Various heating atmosphere used for heat treatment, temperature and atmosphere control– carburising atmosphere and carbon potential measurement, Temperature Measurement Control devices – Nitriding gas atmospheres, quenching media and their characteristics, Stages of Quenching, Various Heat Treatment furnaces- Roller and Mesh type continuous furnaces-fluidised bed furnaces, cryo-chamber, cryo-treatment of steels, sealed quenching furnace, Vacuum furnace, Plasma equipment-Elements of Process control systems-PLC ,PID controllers and continuous monitoring systems.

UNIT V HEAT TREATMENT OF SPECIFIC ALLOYS 9

Heat treatment of special purpose steels – tool steels, high speed steels, maraging steels, HSLA steels and die steels, heat treatment of cast irons – gray cast irons, white cast irons and S.G.irons, austempering of S.G.Iron, heat treatment of non-ferrous alloys – aluminium alloys, copper alloys, nickel alloys and titanium alloys, defects in heat treated parts – causes and remedies.

TOTAL: 45 PERIODS

OUTCOME

- The students will be exposed to the various heat treatment processes that can be applied for different ferrous and non-ferrous alloys.
- The students will understand the effect of the various heat treatments on the microstructure and the properties of materials.

TEXTBOOKS

1. Rajan, T. V., Sharma, C. P., Ashok Sharma., "Heat Treatment Principles And Techniques"Prentice-Hall of India Pvt. Ltd., New Delhi, 2011
2. Vijendra Singh, "Heat Treatment of Metals", Second edition, Standard Publishers Distributors New Delhi, 2012.

REFERENCES

1. Sydney H. Avner, "Introduction to Physical Metallurgy", Tata McGraw Hill, New Delhi, 1997.
2. Prabhudev. K. H. "Handbook of Heat Treatment of Steels", Tata McGraw-Hill Publishing Co., New Delhi, 1988.
3. I. Novikov, "Theory of Heat Treatment of Metals", MIR Publishers, Moscow, 1978
4. ASM Hand book "Heat Treating", Vol.4., ASM International, 1999.

ML7403 IRON AND STEEL MAKING L T P C
3 0 0 3

OBJECTIVE

- The course covers the production of iron and steel from raw material, primary processing and refinement to obtain special steels.

UNIT I RAW MATERIALS AND BURDEN PREPARATION 8

Iron ore classification, Indian iron ores, limestone and coking coal deposits, problems associated with Indian raw materials, Iron ore beneficiation and agglomeration, Briquetting, sintering, Nodulising and pelletizing, testing of burden materials, burden distribution on blast furnace performance.

UNIT II PRINCIPLES AND PROCESSES OF IRON MAKING 10

Blast furnace parts, construction and design aspects, ancillary equipment for charging, preheating the blast, hot blast stoves, gas cleaning, Blast furnace operation, irregularities and remedies, Blast furnace instrumentation and control of furnace Compositional control of metal and slag in blast furnace, modern trends in blast furnace practice.

Reduction of iron ores and oxides of iron by solid and gaseous reductions-thermodynamics and kinetics study of direct and indirect reduction, Gruner's theorem, blast furnace reactions. C-O and Fe-C-O equilibria, Rist diagrams, Ellingham diagram, material and heat balance- Sponge Iron making.

UNIT III PRINCIPLES OF STEEL MAKING 8

Development of steel making processes, physico-chemical principles and kinetic aspects of steel making, carbon boil, oxygen transport mechanism, desulphurisation, dephosphorisation, Slag Theories, slag-functions, composition, properties and theories, raw materials for steelmaking and plant layout.

UNIT IV STEEL MAKING PROCESSES 10

Open Hearth process- constructional features, process types, operation, modified processes, Duplexing, pre-treatment of hot metal. Bessemer processes, Side Blown Converter, Top Blown processes-L.D, L.D.A.C., Bottom blown processes, combined blown processes, Rotating oxygen processes - Kaldo and Rotor, Modern trends in oxygen steel making processes-Electric Arc and Induction furnace-constructional features. Steel Classifications and Standards-National and International- Alloy Designation.

UNIT V LADLE METALLURGY 9

Production practice for plain carbon steels, stainless steels, tool steels and special steels, Secondary steel making processes, continuous steel casting process – Deoxidation and teeming practice. Principle, methods and their comparison, Killed, Rimmed and Capped steels, Degassing practices, ingot production, ingot defects and remedies. Recent trends in steel making technology.

TOTAL: 45 PERIODS

OUTCOME

- The course will enable the student to gain knowledge on the production processes of steel and iron. The student will understand the kinetics involved in the production of iron and steel. The student also gains knowledge on the refinement of steels to obtain a quality product.

TEXTBOOKS

1. Dipak Mazumdar, "A First Course in Iron and Steel Making", Universities press – IIM, Series in Metallurgy and Materials Science, India, 2015.
2. Tupkary, R. H.&Tupkary V.R., "An Introduction to Modern Iron Making", Khanna Publishers, New Delhi, 2004. &"An Introduction to Modern Steel Making", Khanna Publishers, New Delhi, 2000.

REFERENCES

1. Ahindra Ghosh and Amit chatterjee, "Iron Making and Steel Making – Theory and Practice", Prentice Hall of India Private Ltd., New Delhi 2008.
2. Biswas, A. K., "Principles of blast furnace iron making: theory and practice", SBA Publications, Kolkata, 1994.
3. Bashforth, G. R., "Manufacture of Iron and Steel", Vol. I, Chapman and Hall London, 1964.Bashforth, G. R., "Manufacture of Iron and Steel", Vol.2, 3rd Edition, Chapman & Hall,London, 1964
4. "Making, Shaping and Treating of Steel", US Steel Corporation, 11th edition, 1994.

ML7404 MECHANICAL BEHAVIOUR OF MATERIALS L T P C
3 0 0 3

OBJECTIVE

- The students having studied the basics of material structures and properties and strength of materials, shall be introduced to dislocation theories of plasticity behaviour, various strengthening mechanisms and fracture mechanics. It will expose students to failure mechanisms due to fatigue and creep as well as their testing methods.

UNIT I ELASTIC AND PLASTIC BEHAVIOUR 9

Elastic behaviour of materials - Hooke's law, plastic behaviour: dislocation theory - Burger's vectors and dislocation loops, dislocations in the FCC, HCP and BCC lattice, stress fields and energies of dislocations, forces on and between dislocations, dislocation climb, intersections of dislocations, Jogs, dislocation sources, multiplication of dislocations, dislocation pile-ups, Slip and twinning.

UNIT II STRENGTHENING MECHANISMS 10

Elementary discussion of cold working, grain boundary strengthening. Solid solution strengthening, Martensitic strengthening, Precipitation strengthening, Particulate Strengthening, Dispersion strengthening, Fiber strengthening, Examples of above strengthening mechanisms from ferrous and non-ferrous systems, Yield point phenomenon, strain aging and dynamic strain aging

UNIT III FRACTURE AND FRACTURE MECHANICS 9

Types of fracture, Basic mechanisms of ductile and brittle fracture, Griffith's theory of brittle fracture, Orowan's modification. Izod and Charpy Impacts tests, Ductile to Brittle Transition Temperature (DBTT), Factors affecting DBTT, Determination of DBTT.

Fracture mechanics-Introduction, Modes of fracture, Stress intensity factor, Strain energy release rate, Fracture toughness and Determination of KIC, Introduction to COD, J integral.

UNIT IV FATIGUE BEHAVIOUR AND TESTING 8

Fatigue: Stress cycles, S-N curves, Effect of mean stress, Factors affecting Fatigue, Structural changes accompanying fatigue, Cumulative damage, HCF / LCF, thermomechanical fatigue, application of fracture mechanics to fatigue crack propagation, fatigue testing machines- Pari's Equation, Residual life prediction under Fatigue. Macro, Microstructural features of fatigue fracture.

UNIT V CREEP BEHAVIOUR AND TESTING 9

Creep curve, Stages in creep curve and explanation, Structural changes during creep, Creep mechanisms, Metallurgical factors affecting creep, High temperature alloys, Stress rupture testing, Creep testing machines, Parametric methods of extrapolation. Deformation Mechanism Maps according to Frost/Ashby

TOTAL: 45 PERIODS

OUTCOME

- Students will demonstrate and understanding of the mechanical properties and behaviour of materials.
- In the concept of linear elastic fracture mechanics and estimate the effects of cracks in material and structure.
- Students will demonstrate the ability to identify engineering problem in using plastic deformation, fatigue, fracture and creep
- Assues and describe the mechanism loading to failure when provided with a failure example.

TEXTBOOKS

1. Dieter, G. E., "Mechanical Metallurgy", McGraw-Hill Co., SI Edition, 1995
2. Davis, H. E., Troxell G. E. and Hauck, G. E. W., "The Testing of Engineering Materials", McGraw-Hill, 1982.

REFERENCES

1. Wulff, "The Structure and Properties of Materials, Vol. III - Mechanical Behaviour of Materials", John Wiley and Sons, New York, USA, 1983.
2. Honeycombe R. W. K., "Plastic Deformation of Materials", Edward Arnold Publishers, 1984.
3. Suryanarayana, A. V. K., "Testing of Metallic Materials", Prentice Hall India, New Delhi, 1979.
4. Prashant Kumar, "Elements of Fracture Mechanics", McGraw-Hilll, 2009.
5. Thomas H.Courtney, " Mechanical Behaviour of Materials", McGraw-Hilll, Boston, 2nd edition, 2000.

ML7405 POWDER METALLURGY L T P C
3 0 0 3

OBJECTIVE

- This course aims at teaching on powder preparation, characterization, compaction and sintering. This knowledge is essential to understand powder metallurgy applications in aerospace, automobile and machining materials.

UNIT I POWDER MANUFACTURE AND CONDITIONING 12

Mechanical methods Machine milling, ball milling, atomization, shotting- Chemical methods, condensation, thermal decomposition, carbonyl Reduction by gas-hydride, dehydride process, electro deposition, precipitation from aqueous solution and fused salts, hydrometallurgical method. Physical methods: Electrolysis and atomisation processes, types of equipment, factors affecting these processes, examples of powders produced by these methods, applications, powder conditioning, heat treatment, blending and mixing, types of equipment, types of mixing and blending, Self-propagating high-temperature synthesis (SHS), sol-gel synthesis- Nanopowder production methods.

UNIT II CHARACTERISTICS AND TESTING OF METAL POWDERS 8

Sampling, chemical composition purity, surface contamination etc. Particle size and its measurement, Principle and procedure of sieve analysis, microscopic analysis: sedimentation, elutriation, permeability. Adsorption methods and resistivity methods: particle shape, classifications, microstructure. Specific surface area. Apparent and tap density. green density. green strength, sintered compact density, porosity, shrinkage.

UNIT III POWDER COMPACTION 7

Pressureless compaction: slip casting and slurry casting. Pressure compaction- lubrication, single ended and double ended compaction, isostatic pressing, powder rolling, forging and extrusion, explosive compaction.

UNIT IV SINTERING 8

Stage of sintering, property changes, mechanisms of sintering, liquid phase sintering and infiltration, activated sintering, hot pressing and Hot Isostatic Pressing (HIP), vacuum sintering, sintering furnaces-batch and continuous-sintering atmosphere, Finishing operations – sizing,coining, repressing and heat treatment, special sintering processes- microwave sintering, Spark plasma sintering, Field assisted sintering, Reactive sintering, sintering of nanostructured materials.

UNIT V APPLICATIONS of P/M COMPONENTS 10

Major applications in Aerospace, Nuclear and Automobile industries- Bearing Materials-types,Self-lubrication and other types, Methods of production, Properties, Applications. Sintered Friction Materials-Clutches, Brake linings, Tool Materials- Cemented carbides, Oxide ceramics, Cermets-Dispersion strengthened materials.

TOTAL: 45 PERIODS

OUTCOME

- The students will have knowledge on the various ways by which the powder can be prepared, compaction and the sintering methods and mechanisms.
- The students will also be acquainted with the application of various powder metallurgy components.

TEXTBOOKS

1. P.C.Angelo and R.Subramanian.," Powder Metallurgy: Science, Technology and Application" Prentice Hall, 2008
2. Anish Upadhya and G S Upadhaya, "Powder Metallurgy: Science, Technology and Materials, Universities Press, 2011

REFERENCES

1. Sinha A. K., "Powder Metallurgy", Dhanpat Rai& Sons. New Delhi, 1982
2. R.M. German, "Powder Metallurgy and Particulate Materials Processing", Metal PowderIndustries Federation, Princeton, NJ, 2005.
3. ASM Handbook. Vol. 7, "Powder Metallurgy", Metals Park, Ohio, USA, 1990.
4. Animesh Bose., "Advances in Particulate Materials", Butterworth - Heinemann. New Delhi, 1995.
5. Kempton. H Roll, "Powder Metallurgy", Metallurgical Society of AMIE, 1988.

6. Ramakrishnan. P., “Powder Metallurgy-Opportunities for Engineering Industries”, Oxfordand IBH Publishing Co., Pvt. Ltd, New Delhi, 1987.
7. Erhard Klar., “Powder Metallurgy Applications, Advantages and Limitations”, American Society for Metals, Ohio, 1983.
8. Sands. R. L. and Shakespeare. C. R. “Powder Metallurgy”, George Newes Ltd. London,1966

ML7411 HEAT TREATMENT LABORATORY L T P C
0 0 4 2

OBJECTIVE:

- This laboratory course offers practical knowledge of heat treatment processes applicable to Ferrous as wellas Non-Ferrous materials and also to get conversant with the microstructural changes and hardness evaluation.

LIST OF EXPERIMENTS:

1. Annealing and normalising of hardened steels
2. Spheroidization annealing of high carbon steels
3. Effect of quenching media on hardening of steel
4. Effect of tempering temperature and time on tempering of steel
5. Effect of carbon percentage on the hardness of steel
6. Carburizing – Low carbon steel
7. Case hardness depth measurements
8. Austempering treatment
9. Hardenability test – Jominy End Quench Test
10. Heat treatment of cast iron
11. Heat treatment of Stainless Steels and High speed steels
12. Heat treatment of non-ferrous alloys

TOTAL: 60 PERIODS

OUTCOME:

- The students will gain practical knowledge on the various heat treatment processes and also understand the effect of heat treatment on the properties of various materials.

ML7412 POWDER METALLURGY LABORATORY L T P C
0 0 4 2

OBJECTIVE

- This laboratory course offers practical knowledge on powder metallurgy: powder synthesis, compaction and sintering and testing powder compacts and sinters.

LIST OF EXPERIMENTS

1. Powder Production by wet chemical synthesis
2. Powder size reduction by Ball Milling
3. Sieve Analysis Particle size distribution
4. Measurement of Apparent and Tap Density of Powders
5. Measurement of Flow Rate of Powders
6. Determination of optimum compaction pressure.
7. Density determination of sintered product.
8. Fracture Toughness determination of sintered product.
9. Preparation of porous ceramic product.

TOTAL: 60 PERIODS

OUTCOME:

- The course will enable a student to understand and carryout powder metallurgy route involving synthesis, compaction, sintering and appropriate testing methods.

GE7251 ENVIRONMENTAL SCIENCE AND ENGINEERING L T P C
3 0 0 3

OBJECTIVES:

To the study of nature and the facts about environment.

- To find and implement scientific, technological, economic and political solutions to environmental problems.
- To study the interrelationship between living organism and environment.
- To appreciate the importance of environment by assessing its impact on the human world; envision the surrounding environment, its functions and its value.
- To study the dynamic processes and understand the features of the earth's interior and surface.
- To study the integrated themes and biodiversity, natural resources, pollution control and waste management.

UNIT I ENVIRONMENT, ECOSYSTEMS AND BIODIVERSITY 14

Definition, scope and importance of environment – need for public awareness - concept of an ecosystem – structure and function of an ecosystem – producers, consumers and decomposers – energy flow in the ecosystem – ecological succession – food chains, food webs and ecological pyramids – Introduction, types, characteristic features, structure and function of the (a) forest ecosystem (b) grassland ecosystem (c) desert ecosystem (d) aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries) – Introduction to biodiversity definition: genetic, species and ecosystem diversity – biogeographical classification of India – value of biodiversity: consumptive use, productive use, social, ethical, aesthetic and option values – Biodiversity at global, national and local levels – India as a mega-diversity nation – hot-spots of biodiversity – threats to biodiversity: habitat loss, poaching of wildlife, man-wildlife conflicts – endangered and endemic species of India – conservation of biodiversity: In-situ and ex-situ conservation of biodiversity.

Field study of common plants, insects, birds

Field study of simple ecosystems – pond, river, hill slopes, etc.

UNIT II ENVIRONMENTAL POLLUTION 8

Definition – causes, effects and control measures of: (a) Air pollution (b) Water pollution (c)Soil pollution (d) Marine pollution (e) Noise pollution (f) Thermal pollution (g) Nuclear hazards– soil waste management: causes, effects and control measures of municipal solid wastes – role of an individual in prevention of pollution – pollution case studies – disaster management: floods, earthquake, cyclone and landslides.

Field study of local polluted site – Urban / Rural / Industrial / Agricultural.

UNIT III NATURAL RESOURCES 10

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, dams-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 overgrazing, effects of modern agriculture, fertilizer-pesticide 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 induced landslides, soil erosion and desertification – role of an individual in conservation of natural resources – Equitable use of resources for sustainable lifestyles.

Field study of local area to document environmental assets – river / forest / grassland / hill / mountain.

UNIT IV SOCIAL ISSUES AND THE ENVIRONMENT 7

From unsustainable to sustainable development – urban problems related to energy – water conservation, rain water harvesting, watershed management – resettlement and rehabilitation of people; its problems and concerns, case studies – role of non-governmental organization- 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 production act– Air (Prevention and Control of Pollution) act – Water (Prevention and control of Pollution) act – Wildlife protection act – Forest conservation act – enforcement machinery involved in environmental legislation- central and state pollution control boards- Public awareness.

UNIT V HUMAN POPULATION AND THE ENVIRONMENT 6

Population growth, variation among nations – population explosion – family welfare programme – 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.

TOTAL: 45 PERIODS

OUTCOMES:

Environmental Pollution or problems cannot be solved by mere laws. Public participation is an important aspect which serves the environmental Protection. One will obtain knowledge on the following after completing the course.

- Public awareness of environment at infant stage.
- Ignorance and incomplete knowledge has lead to misconceptions.
- Development and improvement in standard of living has lead to serious environmental disasters.

TEXTBOOKS:

1. Gilbert M.Masters, 'Introduction to Environmental Engineering and Science', 2nd edition, Pearson Education 2004.
2. Benny Joseph, 'Environmental Science and Engineering', Tata McGraw-Hill, New Delhi, 2006.

REFERENCES:

1. R.K. Trivedi, 'Handbook of Environmental Laws, Rules, Guidelines, Compliances and Standards', Vol. I and II, Enviro Media.
2. Cunningham, W.P. Cooper, T.H. Gorhani, 'Environmental Encyclopedia',Jaico Publ., House, Mumbai, 2001.
3. Dharmendra S. Sengar, 'Environmental law', Prentice hall of India PVT LTD,New Delhi, 2007.
4. Rajagopalan, R, 'Environmental Studies-From Crisis to Cure', Oxford University Press 2005.

ME7451 MACHINE DESIGN L T P C

(Use of P S G Design Data Book is permitted in the University examination) 3 2 0 4

OBJECTIVES

- To familiarize the various steps involved in the Design Process
- To understand the principles involved in evaluating the shape and dimensions of a component to satisfy functional and strength requirements.
- To learn to use standard practices and standard data
- To learn to use catalogues and standard machine components

UNIT I STEADY STRESSES IN MACHINE MEMBERS 12

Introduction to the design process - factor influencing machine design, selection of materials based on mechanical properties - Preferred numbers, fits and tolerances – Direct, Bending and torsional stress equations – Impact and shock loading – calculation of principle stresses for various load combinations, eccentric loading -Factor of safety – Curved beams - theories of failure – Design for finite and infinite life under variable loading.

UNIT II SHAFTS, COUPLINGS, JOINTS AND BEARINGS 12

Design of solid and hollow shafts based on strength, rigidity and critical speed –Keys, key ways and splines –Rigid and flexible couplings. Welded joints and riveted joints for structures, Sliding contact and rolling contact bearings (Simple problems) .

UNIT III ENERGY STORING ELEMENTS AND ENGINE COMPONENTS 12

Types of springs, Design of helical springs - Flywheels considering stresses in rims and arms for engines and punching machines- Connecting Rods and crank shafts.

UNIT IV DESIGN FOR FLEXIBLE ELEMENTS 12

Design of Flat belts and pulleys - Selection of V belts and pulleys – Design of Transmission chains and Sprockets.

UNIT V SPUR GEARS, HELICAL GEARS AND GEAR BOXES 12

Speed ratios and number of teeth-Force analysis -Tooth stresses - Dynamic effects - Fatigue strength - Factor of safety - Gear materials – Design of straight tooth spur & helical gears based on strength and wear considerations. Geometric progression - Standard step ratio - Ray diagram, kinematics layout -Design of sliding mesh gear box -Constant mesh gear box. – Design of multi speed gear box for machine tool applications – Variable speed gear box .

L=45+T=30, TOTAL: 75 PERIODS

OUTCOME

- Upon completion of this course, the students can able to successfully design machine components

TEXTBOOKS

1. Bhandari V, “Design of Machine Elements”, 3rd Edition, Tata McGraw-Hill Book Co, 2010.

REFERENCES

1. Sundararajamoorthy T. V, Shanmugam .N, “Machine Design”, Anuradha Publications, Chennai, 2003.
2. Joseph Shigley,Charles Mischke,Richard Budynas and Keith Nisbett “Mechanical Engineering Design”, 8th Edition, Tata McGraw-Hill , 2008.
3. Robert C. Juvinall and Kurt M. Marshek, “Fundamentals of Machine Design”,4th Edition, Wiley, 2005
4. Alfred Hall, Halowenko, A and Laughlin, H., “Machine Design”, Tata McGraw-Hill Book Co.(Schaum’s Outline), 2010
5. Bernard Hamrock, Steven Schmid, Bo Jacobson, “Fundamentals of Machine Elements”,2nd Edition, Tata McGraw-Hill Book Co., 2006
6. Orthwein W, “Machine Component Design”, Jaico Publishing Co, 2003.
7. Ansel Ugural, “Mechanical Design – An Integral Approach, 1st Edition, Tata McGraw- Hill Book Co, 2003
8. Merhyle F. Spotts, Terry E. Shoup and Lee E. Hornberger, “Design of Machine Elements” 8th Edition, Printice Hall, 2003.

ML7501 CHARACTERISATION OF MATERIALS -II L T P C
3 0 0 3

OBJECTIVE

- Characterisation of materials is very important for studying the structure of materials and to interpret their properties. The students study the theoretical foundations of metallography, X-ray diffraction, electron diffraction, scanning and transmission electron microscopy as well as surface analysis.

UNIT I METALLOGRAPHIC TECHNIQUES 8

Macroexamination -applications, metallurgical microscope - principle, construction and working, metallographic specimen preparation, optic properties - magnification, numerical aperture, resolving power, depth of focus, depth of field, different light sources lenses aberrations and their remedial measures, various illumination techniques-bright field , dark field, phase-contrast polarized light illuminations, interference microscopy, high temperature microscopy; quantitative metallography – Image analysis

UNIT II X-RAY DIFFRACTION TECHNIQUES 10

Crystallography basics, reciprocal lattice, X-ray generation, absorption edges, characteristic spectrum, Bragg's law, Diffraction methods – Laue, rotating crystal and powder methods. Stereographic projection. Intensity of diffracted beams –structure factor calculations and other factors. Cameras- Laue, Debye-Scherer cameras, Seeman-Bohlin focusing cameras. Diffractometer – General feature and optics, proportional, Scintillating and Geiger counters.

UNIT III ANALYSIS OF X-RAY DIFFRACTION 9

Line broadening, particle size, crystallite size, Precise parameter measurement, Phase identification, phase quantification, Phase diagram determination X-ray diffraction application in the determination of crystal structure, lattice parameter, residual stress – quantitative phase estimation, ASTM catalogue of Materials identification-

UNIT IV ELECTRON MICROSCOPY 9

Construction and operation of Transmission electron microscope – Diffraction effects and image formation, specimen preparation techniques, Selected Area Electron Diffraction, electron-specimen interactions, Construction, modes of operation and application of Scanning electron microscope, Electron probe micro analysis, basics of Field ion microscopy (FIB), Scanning Tunneling Microscope (STM) and Atomic Force Microscope(AFM).

UNIT V SURFACE ANALYSIS 9

Surface chemical composition- Mass spectroscopy and X-ray emission spectroscopy (Principle and limitations) - Energy Dispersive Spectroscopy- Wave Dispersive Spectroscopy- Quadrapole mass spectrometer. Electron spectroscopy for chemical analysis (ESCA), Ultraviolet Photo Electron Spectroscopy (UPS), X ray Photoelectron Spectroscopy (XPS), Auger Electron Spectroscopy (AES), Electron Energy Analysers, Secondary ion mass spectrometry - Applications. Unit meshes of five types of surface nets - diffraction from diperiodic structures using electron, Low Energy Electron Diffraction (LEED), Reflection High Energy Electron Diffraction (RHEED).

TOTAL: 45 PERIODS

OUTCOME

- Ability to perform analysis of X ray diffraction and electon microscope images and the chemical and thermal analysis datas.

TEXTBOOKS

1. Cullity, B. D.," Elements of X-ray diffraction", Addison-Wesley Company Inc., New York,3rd Edition, 2000
2. Phillips V A, "Modern Metallographic Techniques and their Applications", Wiley Eastern,1971.

REFERENCES

1. Brandon D. G, “Modern Techniques in Metallography”, VonNostrand Inc. NJ, USA,1986.
2. Thomas G., “Transmission electron microscopy of metals”, John Wiley, 1996.
3. Weinberg, F., “Tools and Techniques in Physical Metallurgy”, Volume I & II, Marcel and Decker, 1970.
4. Whan R E (Ed), ASM Handbook, Volume 10, Materials Characterisation “, Nineth edition, ASM international, USA, 1986.
5. Haines, P.J.,“ Principles of Thermal Analysis and Calorimetry”, Royal Society of Chemistry (RSC), Cambridge, 2002.
6. D. A. Skoog, F. James Leary and T. A. Nieman, “Principles of Instrumental Analysis”, Fifth Edition, Saunders Publishing Co., 1998

ML7502 THEORY AND APPLICATIONS OF METAL FORMING

L	T	P	C
3	0	0	3

OBJECTIVE

- The basic knowledge on plasticity taught in mechanical metallurgy is extended to theory and applications of metal forming. Various metal forming processes and their analysis are studied in detail.

UNIT I STRESS - STRAIN TENSOR 9

State of stress, components of stress, symmetry of stress tensor, principle stresses, stress deviator, Von Mises, Tresca Yield criteria, comparison of yield criteria, Octahedral shear stress and shear strain, Slip, twinning, Forming load calculations, Strain Rate Tensor.

UNIT II FUNDAMENTALS OF METAL FORMING 9

Classification of forming process- Mechanics of metal working, Flow stress determination, Effect of temperature, strain rate and metallurgical structure on metal working, Friction and lubrication. Deformation zone geometry, Workability, Residual stresses.

UNIT III FORGING AND ROLLING 9

Forging-Hot, Cold and Warm Forging – types of presses and hammers. Classification, Open die forging and Closed die forging, die design, forging in plane strain, calculation of forging loads, use of software for analysis - forging defects – causes and remedies, residual stresses in forging. Rolling: Classification of rolling processes, types of rolling mills, hot and cold rolling, rolling of bars and shapes, forces and geometrical relationship in rolling, analysis of rolling load, torque and power, rolling mill control, rolling defects- causes and remedies.

UNIT IV EXTRUSION AND DRAWING 9

Direct and indirect extrusion, variables affecting extrusion, deformation pattern, equipments, port – hole extrusion die, hydrostatic extrusion, defects and remedies, simple analysis of extrusion ,tube extrusion and production of seamless pipe and tube. Drawing of road, wires and tubes.

UNIT V SHEET METAL FORMING AND OTHER PROCESSES 9

Forming methods – Shearing, Fine and Adiabatic blanking, bending, stretch forming, deep drawing, defects in formed part, sheet metal formability, forming limit diagram.

High velocity forming, Comparison with conventional forming, Explosive forming, Electro hydraulic, Electro Magnetic forming, Dynapark and petroforge forming

TOTAL: 45 PERIODS

OUTCOME

- Ability to make use of mechanical and thermodynamics principle of plastic deformation to form the components using different techniques.

TEXTBOOKS

1. Dieter.G.E., "Mechanical Metallurgy", McGraw – Hill Co., SI Edition, 1995.
2. Surender Kumar, "Technology of Metal Forming Processes", PHI, New Delhi, 2008.

REFERENCES

1. Kurt Lange, "Handbook of Metal Forming", Society of Manufacturing Engineers, Michigan, USA, 1998
2. Nagpal G. R., "Metal Forming Processes", Khanna Pub., New Delhi, 2000
3. Avitzur, "Metal Forming – Process and Analysis", Tata McGraw – Hill Co., New Delhi, 1977.
4. Shiro Kobayshi, Altan. T, Metal Forming and Finite Element Method, Oxford University Press, 1987.
5. Dr.Sadhu Singh, "Theory of plasticity and Metal Forming Processes", Khanna Publishers,2005.

ML7511	MATERIALS CHARACTERISATION LABORATORY-I	L	T	P	C
		0	0	4	2

OBJECTIVE

- This laboratory course offers practical knowledge of analytical instruments to evaluate and analyse the samples.

LIST OF EXPERMENTS:

1. Precision and validity in an experiment using absorption spectroscopy
2. Validating Lambert-Beer's law using KMnO4
3. Finding the molar absorbtivity and stoichiometry using absorption spectrometry.
4. Finding the pKa of 4-nitrophenol using absorption spectroscopy.
5. UV spectroscopic techniques
6. Chromatography analysis using TLC.
7. Chromatography analysis using Column chromatography.
8. Determination of conductivity
9. Determination of vibration band Fourier Transform Infrared Spectroscopy.
10. Determination of decomposition of materials using Thermogravimateric Analysis – Differential Thermal Analysis-Differential scanning calorimetry.
11. Determination of Coefficient of Expansion of material using dilatometer.

TOTAL: 60 PERIODS

OUTCOME

- This lab enable student to select analytical technique to evaluate and analyse the samples. Students learn to use the instruments and get exposed to specimen preparation, validation of instrument, precise use of instrument to accurately estimate the given samples.

ML7512 **METAL FORMING LABORATORY** **L T P C**
0 0 4 2

OBJECTIVE

- To acquire knowledge on basic metal forming processes by experimental study and analysis

LIST OF EXPERIMENTS:

1. Formability of sheet metal by Ericsson cupping test
2. Construction of Formability limit diagram
3. Water hammer test
4. Ring Compression test
5. Diameter reduction in Wire drawing
6. Deep drawing for simple cup shape
7. Extrusion of Cylindrical component
8. Thickness reduction in Sheet metal rolling.
9. Study of Sheet metal forming using FEA analysis software
10. Study of Super plastic forming Process

TOTAL: 60 PERIODS

OUTCOME

- Ability to perform metal forming and welding
- Ability to evaluate the properties of processed component.

ME7554 **INDUSTRIAL MANAGEMENT** **L T P C**
3 0 0 3

OBJECTIVE

- To develop modern concepts of Industrial Management

UNIT I INTRODUCTION **9**

Technology Management - Definition – Functions – Evolution of Modern Management – Scientific management Development of management Thought. Approaches to the study of management, Forms of organization – Individual Ownership- partnership – Joint Stock companies – co-operative Enterprises- Public sector Undertakings, Corporate frame Work – Share Holders- Board of Directors- Committees – Chief Executive – Line and functional Managers, Constraints – Environmental – Financial – Legal- Trade Union

UNIT II FUNCTIONS OF MANAGEMENT **9**

Planning – nature and purpose – objectives – strategies – policies and planning premises – Decision making – Organizing – Nature and process – premises – Departmentalization – line and staff – Decentralization – organizational culture, Staffing – selection and training – placement – performance appraisal – career strategy – organizational development. Leading managing human factor – Leadership – communication, Controlling – process of Controlling – Controlling Techniques – productivity and inventory management systems-Tools of Techniques– Prevention control, industrial safety

UNIT III ORGANIZATIONAL BEHAVIOUR **9**

Definition – Organization – Managerial Role and functions – organizational approaches, individual behavior – causes – Environmental Effect – Behavior and performance, perception – organizational Implications. Personality – Contributing factors – Dimension – Need Theories – process Theories – Job satisfaction, Learning and Behavior- Learning Curves, work design and approaches

UNIT IV GROUP DYNAMICS **9**

Group Behavior – Groups – Contributing factors – Group Norms, Communication – Process – Barriers to communication – Effective Communication, leadership- Formal and informal characteristics- Managerial Grid – Leadership Styles – Group Decision making – Leadership Role in Group Decision, Group Conflicts – Types – Causes – Conflict Resolution – Inter group relations and conflict, Organizational centralization and decentralization – Formal and informal – organizational structures – organizational change and development – Change process – Resistance to change – culture and ethics

UNIT V MODERN CONCEPTS **9**

Management by objectives (MBO) – Strategic Management – SWOT analysis –Evolving development strategies, information technology in management – Decision support system – Management Games – Business Process Re-engineering (BPR) – supply chain management (SCM) –Global Perspective – Principles and Steps – Advantages and Disadvantages

TOTAL: 45 PERIODS

OUTCOME

- The course will enable student preparedness to technology management and the forms of organisation in an industry. This course also enables the student to understand the functions of Management and also the organisational behaviour. It also gives some knowledge on the modern concepts such as Strategic management, SWOT analysis, Business Process Re-engineering (BPR) and supply chain management (SCM).

TEXTBOOKS

1. Herald Koontz and Heinz Weihrich, 'Essentials of Management', McGraw Hill Publishing Company, Singapore International Edition, 1980.
2. M.Govindarajan and S.Natarajan, Principles of Management, Prentice Hall of India Pvt.Ltd. New Delhi 2007

REFERENCES

1. S.Chandran, Organizational Behaviors, Vikas Publishing House Pvt., Ltd, 1994
2. Ties, AF,Stoner and R.Edward Freeman, 'Management' Prentice Hall of India Pvt. Ltd. New Delhi 110011, 1992
3. Joseph J,Massie, 'Essentials of Management' Prentice Hall of India. Ltd. 1985

ML7601	COMPOSITE MATERIALS	L	T	P	C
		3	0	0	3

OBJECTIVE

- Composites are a relatively new class of materials. In this course the students learn about the benefits gained when combining different materials into a composite. The Motive is to make the students to understand different processing methods, issues, properties and testing methods of different composite materials

UNIT I INTRODUCTION TO COMPOSITES **9**

Fundamentals of composites - need for composites – enhancement of properties - classification of composites – Matrix-Polymer matrix composites (PMC), Metal matrix composites (MMC), Ceramic matrix composites (CMC) – Reinforcement – particle reinforced composites, Fibre reinforced composites. Applications of various types of composites. Fiber production techniques for glass, carbon and ceramic fibers

UNIT II POLYMER MATRIX COMPOSITES 9

Polymer resins – thermosetting resins, thermoplastic resins – reinforcement fibres – rovings – woven fabrics – non woven random mats – various types of fibres. PMC processes - hand lay up processes – spray up processes – compression moulding – reinforced reaction injection moulding - resin transfer moulding – Pultrusion – Filament winding – Injection moulding. Fibre reinforced plastics (FRP), Glass Fibre Reinforced Plastics (GFRP). Laminates- Balanced Laminates, Symmetric Laminates, Angle Ply Laminates, Cross Ply Laminates.-applications of PMC in aerospace, automotive industries

UNIT III METAL MATRIX COMPOSITES 9

Characteristics of MMC, various types of metal matrix composites alloy vs. MMC, advantages of MMC, limitations of MMC, Reinforcements – particles – fibres. Effect of reinforcement - volume fraction – rule of mixtures. Processing of MMC – powder metallurgy process - diffusion bonding– stir casting – squeeze casting, a spray process, Liquid infiltration In-situ reactions-Interface-measurement of interface properties- applications of MMC in aerospace, automotive industries

UNIT IV CERAMIC MATRIX COMPOSITES AND SPECIAL COMPOSITES 9

Engineering ceramic materials – properties – advantages – limitations – monolithic ceramics - need for CMC – ceramic matrix - various types of ceramic matrix composites- oxide ceramics – non oxide ceramics – aluminium oxide – silicon nitride – reinforcements – particles- fibres-whiskers. Sintering - Hot pressing – Cold isostatic pressing (CIPing) – Hot isostatic pressing (HIPing). applications of CMC in aerospace, automotive industries- Carbon /carbon composites – advantages of carbon matrix – limitations of carbon matrix carbon fibre – chemical vapour deposition of carbon on carbon fibre perform. Sol-gel technique- Processing of Ceramic Matrix composites.

UNIT V MECHANICS OF COMPOSITES 9

Lamina Constitutive Equations: Lamina Assumptions – Macroscopic Viewpoint. Generalized Hooke's Law. Reduction to Homogeneous Orthotropic Lamina – Isotropic limit case, Orthotropic Stiffness matrix (Qij), Definition of stress and Moment Resultants. Strain Displacement relations.
Basic Assumptions of Laminated anisotropic plates. Laminate Constitutive Equations – Coupling Interactions, Balanced Laminates, Symmetric Laminates, Angle Ply Laminates, Cross Ply Laminates. Laminate Structural Moduli. Evaluation of Lamina Properties from Laminate Tests. Quasi-Isotropic Laminates. Determination of Lamina stresses within Laminates.

TOTAL: 45 PERIODS

OUTCOMES

- Use of different material to design composites
- Use of different techniques to process different types of composites and know the limitations
- Use of Mathematical techniques to predict the macroscopic properties of different Laminates

TEXTBOOKS

1. Mathews F. L. and Rawlings R. D., "Composite Materials: Engineering and Science", Chapman and Hall, London, England, 1st edition, 1994.
2. Chawla K. K., "Composite materials", Springer – Verlag, Second Edition, 1998

REFERENCES

1. Clyne, T. W. and Withers, P. J., "Introduction to Metal Matrix Composites", Cambridge University Press, 1993.
2. Strong, A.B., "Fundamentals of Composite Manufacturing", SME, 1989.
3. Sharma, S.C., "Composite materials", Narosa Publications, 2000.
4. Broutman, L.J. and Krock,R.M., " Modern Composite Materials", Addison-Wesley, 1967.
5. ASM Hand Book, " Composites", Vol.21, ASM International, 2001.

ML7602 NON-DESTRUCTIVE EVALUATION OF MATERIALS

L	T	P	C
3	0	0	3

OBJECTIVE

- To study and understand the various Non-Destructive Evaluation and Testing methods, Interpretation of results, theory and their industrial applications.

UNIT I INTRODUCTION & VISUAL INSPECTION METHODS 7

NDT versus Mechanical testing, Need for NDT, Relative merits and limitations, various physical characteristics of materials and their applications in NDT.

Visual Inspection -Unaided, Aided- Borescopes -Videoscopes, Special features in Borescopes, Selection of borescopes, Optical sensors, Microscopes & replication Microscopy Technique and applications

UNIT II LIQUID PENETRANT TESTING & MAGNETIC PARTICLE TESTING 8

LPT - Principle, types, Procedures, Penetrants and their characteristics, Emulsifiers, Solvent Cleaners / Removers, Developers- properties and their forms, Equipments, Advantages and limitations, Inspection and Interpretation, Applications.

MPT-Principle, Theory of Magnetism, Magnetising current, Magnetisation methods, Magnetic particles, Procedure, Interpretation, Relevant and Non-relevant indications, Residual magnetism, Demagnetisation – need, methods, Advantages and Limitations, Applications, Magnetic Rubber Inspection, Magnetic Printing, Magnetic Painting.

UNIT III THERMOGRAPHY & EDDY CURRENT TESTING 10

Thermography – Introduction, Principle, Contact & Non-Contact inspection methods, Active & Passive methods, Liquid Crystal – Concept, example, advantages &limitations. Electromagnetic spectrum, infrared thermography- approaches, IR detectors, Instrumentation and methodsand applications.

Eddy current Testing – Principle, properties of eddy currents, Eddy current sensing elements, probes, Instrumentation, Types of arrangement, Advantages & Limitations, Interpretation of Results& applications.

UNIT IV ULTRASONIC TESTING & ACOUSTIC EMISSION TESTING 10

Ultrasonic Testing-Principle, Basic Equipment, Transducers, couplants, Ultrasonic wave, Variables in UT, Transmission and Pulse-echo method, Straight beamand angle beam, A-Scan, B-Scan & C-Scan, PhasedArray Ultrasound& Time of Flight Diffraction, Advantages & Limitations, Interpretation of Results& Applications.

Acoustic Emission Technique – Introduction, Types of AE signal, AE wave propagation, Source location, Kaiser effect, AE transducers, Principle, AE parameters, AE instrumentation, Advantages & Limitations, Interpretation of Results, Applications.

UNIT V RADIOGRAPHY 10

Introduction, Principle, X-ray Production, Gamma ray sources, tubing materials, X-ray tubing characteristics, Interaction of X-ray with matter, Imaging, Film techniques, Filmless techniques, Types and uses of filters and screens, Real time radiography, geometric factors, inverse square law, characteristics of film, graininess,density, speed, contrast, characteristic curves, Penetrameters, Exposure charts, Radiographic equivalence. Fluoroscopy- Xero-Radiography, Digital Radiography – Film Digitisation, Direct Radiography &Computed Radiography, Computed Tomography, Gamma ray Radiography, Safety in X- ray and Gamma Rray radiography.

TOTAL: 45 PERIODS

OUTCOME

- Students will be in a better position to evaluate and interpret components / products through NDT either as Quality Assurance Team Member or Production Team Member

TEXT BOOKS

1. ASM Metals Handbook, “Non-Destructive Evaluation and Quality Control”, American Society of Metals, Metals Park, Ohio, USA, 200, Volume-17.
2. Paul E Mix, “Introduction to nondestructive testing: a training guide”, Wiley, 2nd edition New Jersey, 2005

REFERENCES

1. Baldev Raj, T.Jayakumar, M.Thavasimuthu “Practical Non-Destructive Testing”, Narosa Publishing House, 2009.
2. Ravi Prakash, “Non-Destructive Testing Techniques”, New Age International Publishers, 1st revised edition, 2010
3. Charles, J. Hellier,“ Handbook of nondestructive evaluation”, McGraw Hill, New York 2001.
4. G. Gaussorgues, “Infrared Thermography”, Chapman & Hall, University Press, Cambridge, 1994.
5. ASNT, American Society for Non Destructive Testing, Columbus, Ohio, NDT Handbook,Vol. 1, Leak Testing, Vol. 2, Liquid Penetrant Testing, Vol. 3, Infrared and Thermal Testing Vol. 4, Radiographic Testing, Vol. 5, Electromagnetic Testing, Vol. 6, Acoustic Emission Testing, Vol. 7, Ultrasonic Testing.

ML7603 WELDING METALLURGY

L	T	P	C
3	0	0	3

OBJECTIVE

- Metal joining is one of the most important fabrication processes used in the industry and requires both theoretical understanding of the process used and the allied welding metallurgy in order to make a successful weld, the content of the syllabus addresses to the above need.

UNIT I FUNDAMENTALS OF METAL JOINING 9

Welding - Principle of Gas Welding- Equipment-Technique- Principle of Arc –Arc Welding - Electrode types and classification- Gas Tungsten Arc Welding-Gas Metal Arc Welding-Submerged arc Welding-Atomic Hydrogen welding-plasma Arc Welding-Thermit Welding-Electro Slag Welding-Laser Beam Welding, Electron Beam Welding, magnetic pulse Welding-Principle - Resistance Welding - Spot Welding - Projection Welding - Upset Welding - Flash Welding - Forge Welding - Friction Welding, Friction stir welding - Diffusion Bonding - Explosion Welding, Soldering and Brazing-Adhesive Bonding.

UNIT II WELDING METALLURGY PRINCIPLES 9

Thermal cycles in welding: basic heat transfer equations, temperature distributions and cooling curves, dependence of cooling rate on heat input, joint geometry, preheat and other factors. Comparison of welding processes based on these considerations.

UNIT III PHYSICAL METALLURGY OF WELDING 9

Welding of ferrous materials: Iron- Iron carbide diagram, TTT and CCT diagrams, effects of steel composition, formation of different microstructural zones in welded plain-carbon steels. Welding of C-Mn and low-alloy steels, phase transformations in weld and heat - affected zones, cold cracking, role of hydrogen and carbon equivalent, formation of acicular ferrite and effect on weld metal toughness.

UNIT IV WELDING OF ALLOY STEELS AND NON-FERROUS METALS 9

Welding of stainless steels, types of stainless steels, overview of joining ferritic and martensitic types, welding of austenitic stainless steels, Sensitisation, hot cracking, sigma phase and chromium carbide formation, ways of overcoming these difficulties, welding of cast iron. Welding of non-ferrous materials: Joining of aluminium, copper, nickel and titanium alloys, problems encountered and solutions.

UNIT V DEFECTS, WELDABILITY AND STANDARDS 9

Defects in welded joints: Defects such as arc strike, porosity, undercut, slag entrapment and hot cracking, causes and remedies in each case. Joining of dissimilar materials, weldability and testing of weldments.

Introduction to International Standards and Codes

TOTAL: 45 PERIODS

OUTCOME

- The course will enable the student various welding processes used in the industry and solidification process involved in welding and its metallurgy to make a successful weld.

TEXTBOOKS

1. R. S.Parmar, "Welding Engineering and Technology" 2nd edition M/s. Khanna Publishers 2010.
2. Baldev Raj,Shankar V,Bhaduri A K".Welding Technology for Engineers" Narosa Publications 2009.

REFERENCES

1. Saferian. D., "The Metallurgy of Welding". Chapman and Hall, UK, 1985.
2. "AWS Welding Hand book", 9th edition, Vol-1,"Welding Science and Technology", 2001.
3. Sindo Kuo, "Welding Metallurgy", John Wiley & Sons, 2003
4. Henry Granjon, "Fundamentals of Welding Metallurgy", Abington Pub, 1991
5. Robert W. Messler, "Principles of Welding: Processes, Physics, Chemistry, and Metallurgy", Wiley, 1999.
6. Linnert, G. E., "Welding Metallurgy". Vol. 1 and 2. 4th edition. A W S. USA, 1994.
6. Lancaster, J. F. "Metallurgy of Welding", 4th Londre: George Allen & Unwin.1987.

ML7611 COMPOSITE MATERIALS LABORATORY L T P C
0 0 4 2

OBJECTIVE

- Students learn the fabrication processes of different composite materials and the mechanical characterization of these materials

LIST OF Experiments:

1. Preparation of Continuous Fiber reinforced Polymer Composites
2. Preparation of Discontinuous Fiber reinforced Polymer Composites
3. Study of Tensile strength and young's modulus of FRP composites
4. Study of Flexural strength of FRP composites
5. Study of drop weight impact testing
6. Preparation of Al-TiB_2 composite by in-situ reaction
7. Study of Microstructure, hardness and density of Al-TiB_2 composites
8. Preparation of Al-SiC composites by stir casting method
9. Study of microstructure, hardness and density of Al-SiC composite
10. Study of Tensile strength of Al-SiC composites
11. Environmental Testing (Humidity and temperature)

TOTAL: 60 PERIODS

OUTCOME

- The course will enable the student to learn the different fabrication processes of different composite materials and the mechanical characterization of these materials.

ML7612 MATERIALS CHARACTERISATION LABORATORY -II

L	T	P	C
0	0	4	2

OBJECTIVE

- This laboratory gives practical exposure characterization techniques and teaches to interpret results with knowledge gained from the theory subject on characterization of materials.

LIST OF EXPERIMENTS:

1. Determination of precision determination of lattice parameters using an x-ray diffractometer pattern
2. Identification of an unknown structure with the use of database.
3. Fractography analysis using Scanning electron microscopy (SEM)
4. Chemical Analysis using SEM -Energy Dispersive Spectroscopy (EDS).
5. Line scan Analysis using SEM -Energy Dispersive Spectroscopy (EDS).
6. Elemental mapping using SEM-EDS
7. Quantitative image analysis of grain size, grain size distribution, and twin fraction using image analyzer.
   a) Phase fraction and grain size determination
   b) Nodularity and nodule count
8. Study of Wulff net diagram, Stereographic projection & Pole Figures
9. Indexing of SAED (Selected Area Electron Diffraction) patterns of Transmission electron microscopy (TEM)
10. Determination of flaw using Ultrasonic Flaw Detector(UFD)
11. Determination of Young's Modulus of a material using UFD.
12. Determination of index point of angle probe of UFD using Calibration Block.

TOTAL: 60 PERIODS

OUTCOME

- Student will be familiarized to various instruments for characterisation, specific sample preparation, data interpretation, analysis and presentation like XRD, SEM, etc.

ML7701 NONFERROUS METALLURGY

L	T	P	C
3	0	0	3

OBJECTIVE

- To understand the structure, property relations of nonferrous alloys with special emphasis on engineering applications.

UNIT I COPPER AND COPPER ALLOYS **9**

Methods of Production of Copper, Properties and applications of metallic copper. Major alloys of copper and designation- Brasses. Phase diagram of industrially relevant portion. Different compositions, characteristics and uses. Bronzes: Tin bronze. Composition, properties and uses. Other bronzes like Cu-Al, Cu-Si, Cu-Mn and Cu-Be alloys. Cu-Ni alloys.Typical microstructure of copper alloys.

UNIT II ALUMINIUM AND ITS ALLOYS 9

Methods of Production of Aluminium- Properties of metallic aluminium. Alloys of aluminium and designation, classification. Wrought and cast alloys. Heat treatable and nonheat treatable alloys. Age hardening of Al-Cu alloy. Al-Mg-Si, Al-Zn-Mg and Al-Li alloys. Typical microstructure of aluminium alloys. Applications of Al alloys in Automobile an Aircraft industries.

UNIT III MAGNESIUM AND TITANIUM ALLOYS 9

Methods of Production of Magnesium- properties and uses. Magnesium alloys and designation. Methods of Production of Titanium- unique characteristics of the metal- alpha, alpha+beta and beta titanium alloys- major types. Titanium aluminides – their properties and uses. Typical microstructure of magnesium and titanium alloys- Applications of Ti alloys in Aircraft, Chemical and Medical industries.

UNIT IV NICKEL AND ZINC ALLOYS 9

Methods of Production of Nickel-Properties and uses of nickel. Nickel alloys and designation– their properties and uses. Nickel aluminides. Methods of Production of Zinc-Use of zinc in corrosion protection of ferrous materials. Zinc alloys – properties and uses. Typical microstructure of nickel and zinc alloys.

UNIT V LEAD, TIN AND PRECIOUS METALS 9

Methods of Production of Lead and Tin-Major characteristics and applications of lead and tin and their alloys and designation. Low melting nature of solder alloys. Gold, silver and platinum – nobility of these metals. Engineering properties and applications of these metals and their alloys. Typical microstructure of solder alloys.

TOTAL: 45 PERIODS

OUTCOME

- The course will enable a student to understand the production of an alloy, correlate structure - property relations of nonferrous alloys with special emphasis on engineering applications.

TEXTBOOKS

1. Sidney H. Avner, “Introduction to Physical Metallurgy”, Tata McGraw-Hill, 2nd Edition, 1997.
2. K.G.Budinski and M.K.Budinski,”Engineering Materials-- Properties and Selection”, PHI Learning Pvt. Ltd., New Delhi, 2009.

REFERENCES

1. Clark and Varney,”Physical Metallurgy for Engineers”, Affiliated East West Press, New Delhi, 1987
2. William F. Smith,”Structure and Properties of Engineering Alloys”, McGraw Hill, USA, 1993.
3. W.H. Dennis,”Metallurgy of the Nonferrous Metals”, Sir Isaac Pitman and Sons, London,1967.
4. Balram Gupta,”Aerospace Materials”, Vol. 1, 2 and 3, S. Chand and Co., New Delhi, 1996.
5. Ahindra Ghosh, Hem Shanker Ray, “Principles of Extractive Metallurgy”, New Age International, Reprint 2001.

ML7751 **SURFACE ENGINEERING** **L T P C**
3 0 0 3

OBJECTIVE

- The subject provides knowledge on various types of corrosion, their kinetics, testing and methods of protection as well as introduction to tribology.

UNIT I INTRODUCTION 12

Introduction to tribology, surface degradation, wear and corrosion, types of wear, adhesive, abrasive, oxidative, corrosive, erosive and fretting wear, roles of friction and lubrication-, expressions for corrosion rate. emf and galvanic series - merits and demerits -Pourbaix diagram for iron, magnesium and aluminium. Forms of corrosion - Uniform, pitting, intergranular, stress corrosion. corrosion fatigue. dezincification. erosion corrosion, crevice corrosion - Cause and remedial measures - Pilling Bedworth ratio - High temperature oxidation-Hydrogen embrittlement-Remedial Measures.

UNIT II KINETICS OF CORROSION 8

Exchange current density, polarization - concentration, activation and resistance, Tafel quation; passivity, electrochemical behaviour of active/passive metals, Flade potential, theories of passivity, Effect of oxidising agents

UNIT III CORROSION OF INDUSTRIAL COMPONENTS 8

Corrosion in fossil fuel power plants, Automotive industry, Chemical processing industries, corrosion in petroleum production operations and refining, Corrosion of pipelines.

UNIT IV TESTING 8

Purpose of corrosion testing - Classification - Susceptibility tests for intergranular corrosion-Stress corrosion test. Salt spray test humidity and porosity tests, accelerated weathering tests. ASTM standards for corrosion testing and tests for assessment of wear

UNIT V PROTECTION METHODS 9

Organic, Inorganic and Metallic coatings, Electroless plating and Anodising - Cathodic protection, corrosion inhibitors - principles and practice - inhibitors for acidic neutral and other media. Special surfacing processes - CVD and PVD processes, sputter coating. Laser and ion implantation, Arc spray, plasma spray, Flame spray, HVOF.

TOTAL: 45 PERIODS

OUTCOME

- Ability to control the factors that affect the metal corrosion.
- Ability to measure the corrosion rate.
- Ability to prevent corrosion by coatings and inhibitors, etc.

TEXTBOOKS

1. Fontana and Greene. “Corrosion Engineering”. McGraw Hill Book Co. New York. USA,1986.
2. Raj Narayan. “An Introduction to Metallic Corrosion and its prevention”, Oxford & 1BH, New Delhi,1983.

REFERENCES

1. Kenneth G Budinski. “Surface Engineering for Wear Resistance”. Prentice Hall Inc..Engelwood Cliff., New Jersey. USA 1988
2. Denny A. Jones,”Principles and Prevention of Corrosion” 2nd Edition, Prentice Hall of India,1996.
3. Uhlig. H.H. “Corrosion and Corrosion Control”. John Wiley & Sons. New York. USA. 1985.
4. ASM Metals Handbook. Vol.5. “Surface Engineering”. ASM Metals Park. Ohio. USA. 1994.
5. ASM Metals Handbook. Vol.l3,”Corrosion”. ASM Metals Park. Ohio. USA. 1994

ML7711	CREATIVE AND INNOVATIVE PROJECT	L	T	P	C
		0	0	4	2

OBJECTIVE

- This laboratory course is train students to scientifically investigate of problem in the area of materials engineering, collect literature, hypothesize a solution, plan and execute activities of project with creativeness and innovation involving material processing, testing and characterization

The goal of this course is to help students to identify innovative projects that promotes and inhibit creativity to explore the variables that affect creativity and innovation. By the end of the period, students should be familiar with current thinking in their field, and able to apply the concepts to relevant research problems or practical applications.
The goal of this course is to drive them to learn concepts, models, frameworks, and tools that engineering graduates' need in a world where creativity and innovation is fast becoming a pre-condition for competitive advantage.
Each student will choose a nagging workplace problem or socially relevant problems that have been difficult for them to "solve." At the end of the semester, each or group of students have to submit a report for evaluation.

TOTAL: 60 PERIODS

OUTCOME

- Student will know to define a problem, survey literature, systematic approach of planning and execution of activities as an individual or as a group in attempting a solution for a problem in materials engineering.

ML7712	SURFACE ENGINEERING LABORATORY	L	T	P	C
		0	0	4	2

OBJECTIVE

- This laboratory course offers hands on experience on some surface modification technologies, corrosion and wears studies.

LIST OF EXPERIMENTS

1. Estimation of corrosion rate of mild steel by weight loss method and determination of inhibitor efficiency in acid and neutral media.
2. Electroplating of Cu and Ni
3. Electroless nickel coating
4. Oxalic acid etch test for intergranular corrosion (Streicher test)
5. Evaluation of corrosion characteristics by potentiostatic /galvanostatic polarisation techniques - Study of passivation characteristics of MS and SS steels in acid media
6. Evaluation of corrosion characteristics by potentiostatic/galvanostatic polarisation techniques - Determination of pitting potential of various steels
7. Evaluation of corrosion characteristics by potentiostatic /galvanostatic polarisation techniques – Potentiostatic investigation of the effectiveness of inhibitors
8. Determination of wear, wear rate and wear characteristics pin on disc wear testing

TOTAL: 60 PERIODS

OUTCOME

- Student will be able to carry out surface modifications, evaluate their corrosion and wear characteristics by interpretation of results.

ML7713 **INDUSTRIAL TRAINING** **L T P C**
0 0 0 2

OBJECTIVE:
This course is mandatory to gain exposure to applications in industry.

The students have to undergo practical industrial training for four weeks (during vacation at the end of VI semester) in recognized industrial establishments. At the end of the training they have to submit a report with following information:

1. Profile of the Industry
2. Product range
3. Organisation structure
4. Plant layout
5. Processes/Machines/Equipment/devices
6. Personnel welfare schemes
7. Details of the training undergo
8. Projects undertaken during the training, if any
9. Learning points.

End Semester examination will be a Viva-Voce Examination.

OUTCOMES

- Ability to present the Industrial activities and know about process/product/magnet techniques under in the Industries.

ML7811 **PROJECT WORK** **L T P C**
0 0 20 10

OBJECTIVE:
To develop the ability to solve a specific problem right from its identification and literature review till the successful solution of the same.
To train the students in preparing project reports and to face reviews and viva voce examination.
A project topic must be selected by the students in consultation with their guides.
The aim of the project work is to deepen comprehension of principles by applying them to a new problem which may be the design and fabrication of a device for a specific application, a research project with a focus on an application needed by the industry/society, a computer project, a management project or a design project.
The progress of the project is evaluated based on a minimum of three reviews.
The review committee may be constituted by the Head of the Department. A project report is required at the end of the semester. The project work is evaluated jointly by external and internal examiners constituted by the Head of the Department based on oral presentation and the project report.

TOTAL :300 PERIODS

OUTCOME:

- Upon completion of this course, the students will be able to take up any challenging practical problems and find solution by formulating proper methodology.

GE7071	DISASTER MANAGEMENT	L	T	P	C
		3	0	0	3

OBJECTIVE

- To provide students an exposure to disasters, their significance and types.
- To ensure that students begin to understand the relationship between vulnerability, disasters, disaster prevention and risk reduction
- To gain a preliminary understanding of approaches of Disaster Risk Reduction (DRR)
- To enhance awareness of institutional processes in the country and
- To develop rudimentary ability to respond to their surroundings with potential disaster response in areas where they live, with due sensitivity

UNIT I INTRODUCTION TO DISASTERS 9

Definition: Disaster, Hazard, Vulnerability, Resilience, Risks – Disasters: Types of disasters – Earthquake, Landslide, Flood, Drought, Fire etc - Classification, Causes, Impacts including social, economic, political, environmental, health, psychosocial, etc.- Differential impacts- in terms of caste, class, gender, age, location, disability - Global trends in disasters: urban disasters, pandemics, complex emergencies, Climate change- Dos and Don'ts during various types of Disasters.

UNIT II APPROACHES TO DISASTER RISK REDUCTION (DRR) 9

Disaster cycle - Phases, Culture of safety, prevention, mitigation and preparedness community based DRR, Structural- nonstructural measures, Roles and responsibilities of- community, Panchayati Raj Institutions/Urban Local Bodies (PRIs/ULBs), States, Centre, and other stake-holders- Institutional Processess and Framework at State and Central Level- State Disaster Management Authority(SDMA) – Early Warning System – Advisories from Appropriate Agencies.

UNIT III INTER-RELATIONSHIP BETWEEN DISASTERS AND DEVELOPMENT 9

Factors affecting Vulnerabilities, differential impacts, impact of Development projects such as dams, embankments, changes in Land-use etc.- Climate Change Adaptation- IPCC Scenario and Scenarios in the context of India - Relevance of indigenous knowledge, appropriate technology and local resources.

UNIT IV DISASTER RISK MANAGEMENT IN INDIA 9

Hazard and Vulnerability profile of India, Components of Disaster Relief: Water, Food, Sanitation, Shelter, Health, Waste Management, Institutional arrangements (Mitigation, Response and Preparedness, Disaster Management Act and Policy - Other related policies, plans, programmes and legislation – Role of GIS and Information Technology Components in Preparedness, Risk Assessment, Response and Recovery Phases of Disaster – Disaster Damage Assessment.

UNIT V DISASTER MANAGEMENT: APPLICATIONS AND CASE STUDIES AND FIELD WORKS 9

Landslide Hazard Zonation: Case Studies, Earthquake Vulnerability Assessment of Buildings and Infrastructure: Case Studies, Drought Assessment: Case Studies, Coastal Flooding: Storm Surge Assessment, Floods: Fluvial and Pluvial Flooding: Case Studies; Forest Fire: Case Studies, Man Made disasters: Case Studies, Space Based Inputs for Disaster Mitigation and Management and field works related to disaster management.

TOTAL: 45 PERIODS

OUTCOME

- Differentiate the types of disasters, causes and their impact on environment and society
- Assess vulnerability and various methods of risk reduction measures as well as mitigation.
- Draw the hazard and vulnerability profile of India, Scenarious in the Indian context, Disaster damage assessment and management.

TEXTBOOKS

1. Singhal J.P. "Disaster Management", Laxmi Publications, 2010. ISBN-10: 9380386427 ISBN-13: 978-9380386423
2. Tushar Bhattacharya, "Disaster Science and Management", McGraw Hill India Education Pvt. Ltd., 2012. **ISBN-10:** 1259007367, **ISBN-13:** 978-1259007361

REFERENCES

1. Gupta Anil K, Sreeja S. Nair. Environmental Knowledge for Disaster Risk Management, NIDM, New Delhi, 2011
2. Kapur Anu Vulnerable India: A Geographical Study of Disasters, IIAS and Sage Publishers, New Delhi, 2010.
3. Govt. of India: Disaster Management Act , Government of India, New Delhi, 2005
4. Government of India, National Disaster Management Policy, 2009.

GE7074 HUMAN RIGHTS L T P C
3 0 0 3

OBJECTIVES :

- To sensitize the Engineering students to various aspects of Human Rights.

UNIT I **9**

Human Rights – Meaning, origin and Development. Notion and classification of Rights – Natural, Moral and Legal Rights. Civil and Political Rights, Economic, Social and Cultural Rights; collective / Solidarity Rights.

UNIT II **9**

Evolution of the concept of Human Rights Magana carta – Geneva convention of 1864. Universal Declaration of Human Rights, 1948. Theories of Human Rights.

UNIT III **9**

Theories and perspectives of UN Laws – UN Agencies to monitor and compliance.

UNIT IV **9**

Human Rights in India – Constitutional Provisions / Guarantees.

UNIT V **9**

Human Rights of Disadvantaged People – Women, Children, Displaced persons and Disabled persons, including Aged and HIV Infected People. Implementation of Human Rights – National and State Human Rights Commission – Judiciary – Role of NGO's, Media, Educational Institutions, Social Movements.

TOTAL : 45 PERIODS

OUTCOME :

- Engineering students will acquire the basic knowledge of human rights.

REFERENCES:

1. Kapoor S.K., “Human Rights under International law and Indian Laws”, Central Law Agency, Allahabad, 2014.
2. Chandra U., “Human Rights”, Allahabad Law Agency, Allahabad, 2014.
3. Upendra Baxi, The Future of Human Rights, Oxford University Press, New Delhi.

GE7652 TOTAL QUALITY MANAGEMENT L T P C
3 0 0 3

AIM

- To provide comprehensive knowledge about the principles, practices, tools and techniques of Total quality management.

OBJECTIVES

- To understand the need for quality, its evolution, basic concepts, contribution of quality gurus, TQM framework, Barriers and Benefits of TQM.
- To understand the TQM Principles.
- To learn and apply the various tools and techniques of TQM.
- To understand and apply QMS and EMS in any organization.

UNIT I INTRODUCTION 9

Introduction - Need for quality - Evolution of quality - Definition of quality - Dimensions of product and service quality –Definition of TQM-- Basic concepts of TQM –-Gurus of TQM (Brief introduction) -- TQM Framework- Barriers to TQM –Benefits of TQM.

UNIT II TQM PRINCIPLES 9

Leadership--The Deming Philosophy, Quality council, Quality statements and Strategic planning--Customer Satisfaction –Customer Perception of Quality, Feedback, Customer complaints, Service Quality, Kano Model and Customer retention – Employee involvement – Motivation, Empowerment, Team and Teamwork, Recognition & Reward and Performance Appraisal--Continuous process improvement –Juran Trilogy, PDSA cycle, 5s and Kaizen - Supplier partnership – Partnering, Supplier selection, Supplier Rating and Relationship development.

UNIT III TQM TOOLS & TECHNIQUES I 9

The seven traditional tools of quality – New management tools – Six-sigma Process Capability–Bench marking – Reasons to bench mark, Bench marking process, What to Bench Mark, Understanding Current Performance, Planning, Studying Others, Learning from the data, Using the findings, Pitfalls and Criticisms of Bench Marking – FMEA – Intent of FMEA, FMEA Documentation, Stages, Design FMEA and Process FMEA.

UNIT IV TQM TOOLS & TECHNIQUES II 9

Quality circles – Quality Function Deployment (QFD) – Taguchi quality loss function – TPM – Concepts, improvement needs – Performance measures-- Cost of Quality - BPR.

UNIT V QUALITY MANAGEMENT SYSTEM 9

Introduction—Benefits of ISO Registration—ISO 9000 Series of Standards—Sector-Specific Standards—AS 9100, TS16949 and TL 9000-- ISO 9001 Requirements—Implementation—Documentation—Internal Audits—Registration--**ENVIRONMENTAL MANAGEMENT SYSTEM:** Introduction—ISO 14000 Series Standards—Concepts of ISO 14001—Requirements of ISO 14001—Benefits of EMS.

TOTAL: 45 PERIODS

OUTCOMES:

- Ability to apply TQM concepts in a selected enterprise.
- Ability to apply TQM principles in a selected enterprise.
- Ability to apply the various tools and techniques of TQM.
- Ability to apply QMS and EMS in any organization.

TEXT BOOK:

1. Dale H.Besterfiled, Carol B.Michna,Glen H. Besterfield,Mary B.Sacre,Hemant Urdhwareshe and Rashmi Urdhwareshe, "Total Quality Management", Pearson Education Asia, Revised Third Edition, Indian Reprint, Sixth Impression,2013.

REFERENCE:

1. James R. Evans and William M. Lindsay, "The Management and Control of Quality", (6th Edition), South-Western (Thomson Learning), 2005.
2. Oakland, J.S. "TQM – Text with Cases", Butterworth – Heinemann Ltd., Oxford, Third Edition, 2003.
3. Suganthi,L and Anand Samuel, "Total Quality Management", Prentice Hall (India) Pvt. Ltd., 2006 .
4. Janakiraman,B and Gopal, R.K, "Total Quality Management – Text and Cases",Prentice Hall (India) Pvt. Ltd., 2006.

IE7751 DESIGN OF EXPERIMENTS L T P C
3 0 0 3

AIM:

- This course aims to introduce students how to statistically plan, design and execute industrial experiments for process understanding and improvement in both manufacturing and service environments

OBJECTIVES:

- To demonstrate knowledge and understanding of Classical Design of Experiments (DOE)
- To demonstrate knowledge and understanding of Taguchi's approach
- To develop skills to design and conduct experiments using DOE and Taguchi's approach
- To develop competency for analysing the data to determine the optimal process parameters that optimize the process.

UNIT I FUNDAMENTALS OF EXPERIMENTAL DESIGNS 9

Hypothesis testing – single mean, two means, dependant/ correlated samples – confidence intervals, Experimentation – need, Conventional test strategies, Analysis of variance, F-test, terminology, basic principles of design, steps in experimentation – choice of sample size – Normal and half normal probability plot – simple linear and multiple linear regression, testing using Analysis of variance.

UNIT II SINGLE FACTOR EXPERIMENTS 9

Completely Randomized Design- effect of coding the observations- model adequacy checking - estimation of model parameters, residuals analysis- treatment comparison methods- Duncan's multiple range test, Newman-Keuel's test, Fisher's LSD test, Tukey's test- testing using contrasts- Randomized Block Design – Latin Square Design- Graeco Latin Square Design – Applications.

UNIT III FACTORIAL DESIGNS 9

Main and Interaction effects - Two and three factor full factorial designs- Fixed effects and random effects model - Rule for sum of squares and Expected Mean Squares- 2^K Design with two and three factors- Yate's Algorithm- fitting regression model- Randomized Block Factorial Design - Practical applications.

UNIT IV SPECIAL EXPERIMENTAL DESIGNS 9

Blocking and Confounding in 2^K Designs- blocking in replicated design- 2^K Factorial Design in two blocks- Complete and partial confounding- Confounding 2^K Design in four blocks- Two level Fractional Factorial Designs- one-half fraction of 2^K Design, design resolution, Construction of one-half fraction with highest design resolution, one-quarter fraction of 2^K Design- introduction to response surface methods, central composite design.

UNIT V TAGUCHI METHODS 9

Design of experiments using Orthogonal Arrays, Data analysis from Orthogonal experiments- Response Graph Method, ANOVA- attribute data analysis- Robust design- noise factors, Signal to noise ratios, Inner/outer OA design- case studies.

TOTAL : 45 PERIODS

OUTCOMES:

- To understand the fundamental principles of Classical Design of Experiments
- To apply DOE for process understanding and optimisation
- To describe the Taguchi's approach to experimental design for process performance robustness
- To apply Taguchi based approach to evaluate quality

TEXT BOOK:

1. Douglas C. Montgomery, "Design and Analysis of Experiments", John Wiley & sons, 2012.

REFERENCES:

1. Krishnaiah K, and Shahabudeen P, "Applied Design of Experiments and Taguchi Methods", PHI, India, 2011.
2. Phillip J. Ross, "Taguchi Techniques for Quality Engineering", Tata McGraw-Hill, India, 2005.
3. Box, G. E., Hunter,W.G., Hunter, J.S., Hunter,W.G., "Statistics for Experimenters: Design, Innovation, and Discovery", 2nd Edition, Wiley, 2005.

ME7020 APPLIED THERMAL ENGINEERING

L	T	P	C
3	0	0	3

OBJECTIVE

- To apply the concepts and laws of thermodynamics for heat engines - Internal Combustion(IC) engines, Compressor, Gas Turbines, Boilers, Refrigeration and Air Conditioning Systems.

UNIT I GAS AND VAPOUR POWER CYCLES 9

Air Standard Cycles - Otto, Diesel, Dual, Brayton, Rankine – cycle Analysis and performance calculations

UNIT II INTERNAL COMBUSTION ENGINES AND ITS SYSTEMS 9

IC engine Classification, components and functions. Actual and theoretical - valve and port timing diagrams, Comparison of two stroke & four stroke engines and SI & CI engines. Air-fuel ratio calculation – lean and rich mixtures. Combustion in SI & CI Engines Ignition, lubrication and cooling systems. Exhaust gas analysis.

UNIT III STEAM NOZZLE AND BOILERS 9

Types of nozzles, Flow of steam through nozzles, Shapes of nozzles, Effect of friction, Critical pressure ratio, Metastable flow. Types of boilers, Thermal calculations, Heat balance, Mountings and Accessories,

UNIT IV GAS TURBINES AND STEAM TURBINES 9

Open and closed Gas turbine cycle analysis - methods of cycle improvement. Regenerative, intercooled, reheated cycles and their combinations.

Types, Impulse and reaction principles, Compoundings, Velocity diagrams for impulse and reaction blades, Work done on turbine blades and efficiency of components, Cogeneration Principles, Cycle Analysis.

UNIT V COMPRESSION , REFRIGERATION AND AIR – CONDITIONING 9

Classification and working principle, work of compression with and without clearance. Volumetric efficiency, Isothermal efficiency and isentropic efficiency of reciprocating air compressors. Multistage air compressor and inter cooling – work of multistage air compressor.

Vapour compression Refrigeration cycle, Superheat, Sub cooling, Performance calculations, Working principle of vapour absorption system, Air cycle refrigeration, Psychrometry and Psychrometric properties, Psychrometric chart, Instrumentation, Cooling load calculations and circulating systems, Air conditioning systems.

TOTAL: 45 PERIODS

OUTCOME

- Students will have overview of applied thermal engineering which will help to understand materials development and working conditions related to thermal shock, hot corrosion, etc.

TEXTBOOKS

1. Rajput, R.K., Thermal Engineering, 8th Edition, Laxmi Publications, 2010
2. Ballaney, P.L., “Thermal Engineering” , Khanna Publishers, 24th Edition, 2003.

REFERENCES

1. Rathore, M.M, Thermal Engineering, McGraw Hill, 2010.
2. Rudramoorthy, R., Thermal Engineering, 4th Edition, Tata McGraw Hill, New Delhi, 2006
3. Domkundwar, Kothandaraman, and Domkundwar, A Course in Thermal Engineering, Dhanpat Raj & Sons, Fifth edition, 2002.
4. Sarkar B K, Thermal Engineering, McGraw Hill, 2001
5. Zucro,N.J., Principles of jet propulsion and gas turbines, John Wiley, New York, 1970.
6. Ganesan.V, Gas turbines, Tata McGraw-Hill Publication, New Delhi, 1999
7. Somasundaram, Gas Dynamic and Jet propulsion, New Age Internatiolnal, 1996.
8. Arora .C.P., “Refrigeration and Air Conditioning”, TMH, 1994.
9. Charles H Butler : Cogeneration” McGraw Hill, 1984.

ME7071 AUTOMOBILE ENGINEERING

L	T	P	C
3	0	0	3

OBJECTIVE:

- To provide a first course of teaching such that the learners are able to visualise the scope of Automobile Engineering.

UNIT I INTRODUCTON TO AUTOMOTIVES 9

An overview of different types of automobiles and their power sources. Specifications, Performance Parameters, Quality standards, Trends in automobile design.

UNIT II POWER SOURCE FEATURES 9

Reciprocating Engine systems, Rotary Engine systems, Gas Turbine systems, Hybrid systems. Pollutant emissions and their control; Catalytic converter systems, Electronic Engine Management systems.

UNIT III TRANSMISSION, SUSPENSION AND BRAKING SYSTEMS 9

Clutch system, Gear box system, propeller shafting, differential, axles, wheels and tyres and preliminaries of suspension systems.

UNIT IV AUXILIARY SYSTEMS 9

Electrical and electronic systems, safety systems, Heating, Ventilation, and Air Conditioning (HVAC) systems, Vehicle Thermal Management System and vehicle body design features.

UNIT V TESTS, SERVICE AND MAINTENANCE 9

Engine Tuning, vehicle maintenance, engine and Chassis Dynamometry Pollutants and emissions check, Wind Tunnel Tests, preliminaries of engine and vehicle testing.

TOTAL:45 PERIODS

OUTCOMES:

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

- Identify the different components in an automobile.
- Clearly understand different auxiliary and transmission systems.

TEXT BOOK:

1. William H. Crouse and Donald L. Anglin, “Automotive Mechanics”, Tata McGraw Hill, 2004, Tenth Edition.

REFERENCES:

1. Bosch “Automotive Handbook”, Robert Bosch GmbH, Germany, 2004, Sixth Edition.
2. Jack Erjavek, “Automotive Technology – A Systems Approach”, Thomson Learning, 3rd Edition, 1999.

ME7077 ENTREPRENEURSHIP DEVELOPMENT

L	T	P	C
3	0	0	3

OBJECTIVE:

- The students will be provided with an understanding of the scope of an entrepreneur, key areas of development, financial assistance by the institutions, methods of taxation and tax benefits, etc.

UNIT I ENTREPRENEURSHIP 9

Entrepreneur – Characteristics – Types of Entrepreneurs – Difference between Entrepreneur and Intrapreneur – Role of Entrepreneurship in Economic Development – Factors Affecting Entrepreneurial Growth – Economic, Non Economic, Government Actions.

UNIT II MOTIVATION 9

Entrepreneurial Motivation: Theories and Factors, Achievement Motivation –Entrepreneurial Competencies – Entrepreneurship Development Programs – Need, Objectives – Business Game, Thematic Apperception Test, Self Rating, Stress management.

UNIT III BUSINESS **9**

Small Enterprises – Definition, Characteristics, Project Identification and selection – Project Formulation: Significance, content, formulation of project report – Project Appraisal: Concept and method – Ownership Structures: Selection & Pattern.

UNIT IV FINANCING AND ACCOUNTING **9**

Finance: Need, Sources, Capital Structure, Term Loans – Accounting: Need, Objectives, Process, Journal, Ledger, Trial Balance, Final Accounts – Working Capital Management: Significance, Assessment, Factors, Sources, Management.

UNIT V SUPPORT TO ENTREPRENEURS **9**

Sickness in small Business: Concept, Signals, Symptoms, Magnitude, Causes and Consequences, Corrective Measures – Government Policy for Small Scale Enterprises: Growth Policy, Support. Institutional Support to Entrepreneurs: Need and Support – Taxation Benefits to Small Scale Industry: Need, Depreciation, Rehabilitation, Investment.

TOTAL:45 PERIODS

OUTCOME:

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

- Gain knowledge and skills needed to run a business successfully.

TEXT BOOKS:

1. S.S.Khanka, "Entrepreneurial Development" S.Chand & Co. Ltd. Ram Nagar New Delhi,1999.
2. Kurahko & Hodgetts, " Entrepreneurship – Theory, process and practices", Thomson learning 6th edition.

REFERENCES:

1. Hisrich R D and Peters M P, "Entrepreneurship" 5th Edition Tata McGraw-Hill, 2002.
2. Mathew J Manimala," Entrepreneurship theory at cross roads: paradigms and praxis" Dream tech, 2nd edition 2006.
3. Rabindra N. Kanungo, "Entrepreneurship and innovation", Sage Publications, New Delhi, 1998.

ME7080 MARKETING MANAGEMENT **L T P C**
3 0 0 3

OBJECTIVE:

- To expose the students to newer concepts of marketing principles like strategic marketing concepts, segmentation, pricing, advertisement and strategic formulation.

UNIT I CONCEPTS IN MARKETING **9**

Definition, Marketing Process, Dynamics, Needs, Wants and Demands, Marketing Concepts, Environment, Mix, Types, Philosophies, Selling vs Marketing, Consumer Goods, Industrial Goods.

UNIT II BUYING BEHAVIOUR AND MARKET SEGMENTATION **9**

Cultural, Demographic factors, Motives, Types, Buying Decisions, Segmentation factors, Demographic, Psycho graphic and Geographic Segmentation, Process, Patterns. Services marketing and Industrial marketing.

UNIT III PRODUCT, PRICE AND MARKETING RESEARCH **9**

Product, Classifications of product, Product Hierarchy, Product Life Cycle, New product development, Branding.

Price: Objectives, Pricing Decisions and Pricing Methods, Pricing Management, Introduction, Uses, Process of Marketing Research.

UNIT IV MARKETING PLANNING AND STRATEGY FORMULATION 9

Components of a Marketing Plan, Strategy Formulation and the Marketing Process, Implementation, Portfolio Analysis, BCG, GEC Grids.

UNIT V ADVERTISING, SALES PROMOTION & DISTRIBUTION 9

Advertising-Characteristics, Impact, Goals, Types, Sales Promotion – Point of purchase, Unique Selling Propositions, Characteristics, Wholesaling, Retailing, Channel Design, Logistics, Modern Trends in Retailing, Modern Trends, e-Marketing.

TOTAL:45 PERIODS

OUTCOME:

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

- Understand the philosophies of marketing and should able to formulate market planning, strategies and could promote sales in effective manner**.**

TEXT BOOKS:

1. Govindarajan. M, "Marketing management – concepts, cases, challenges and trends", Prentice hall of India, second edition, 2007.
2. Philip Kolter & Keller, "Marketing Management", Prentice Hall of India, XII edition, 2006.

REFERENCES:

1. Donald S. Tull and Hawkins, "Marketing Research", Prentice Hall of Inida-1997.
2. Philip Kotler and Gary Armstrong "Principles of Marketing" Prentice Hall of India, XII Edn, 2000.
3. Ramasamy and Nama kumari, "Marketing Management**:** Planning, Implementation and Control, Macmillan and Company,", 2002
4. Czinkota&Kotabe, "Marketing management", Thomson learning, Indian edition 2007
5. Adrain palmer, "Introduction to marketing theory and practice", Oxford university press IE 2004.

ME 7351 DESIGN CONCEPTS IN ENGINEERING

L	T	P	C
3	0	0	3

OBJECTIVES:

- To impart the importance of design in todays context of global competition, environmental awareness and customer oriented market.
- To impart the basic concepts and various aspects of design using simple examples and case studies.

UNIT I DESIGN TERMINOLOGY 9

Definition-various methods and forms of design-importance of product design-static and dynamic products-various design projects-morphology of design-requirements of a good design-concurrent engineering-computer aided engineering-codes and standards-product and process cycles-bench marking.

UNIT II DESIGN PROCESS 9

Basic modules in design process-scientific method and design method-Need identification, importance of problem definition-structured problem, real life problem- information gathering - customer requirements- Quality Function Deployment (QFD)- product design specifications-generation of alternative solutions- Analysis and selection-Detail design and drawings-Prototype, modeling, simulation, testing and evaluation.

UNIT III CREATIVITY IN DESIGN 9

Creativity and problem solving-vertical and lateral thinking-invention-psychological view, mental blocks-Creativity methods-brainstorming, synectics, force fitting methods, mind map, concept map-Theory of innovative problem solving (TRIZ) - conceptual decomposition creating design concepts.

UNIT IV HUMAN AND SOCIETAL ASPECTS 9

Human factors in design, ergonomics, user friendly design-Aesthetics and visual aspects environmental aspects-marketing aspects-team aspects-legal aspects-presentation aspects.

UNIT V MATERIAL AND PROCESSES IN DESIGN 9

Material selection for performance characteristics of materials-selection for new design substitution for existing design-economics of materials-selection methods-recycling and material selection-types of manufacturing process, process systems- Design for Manufacturability (DFM) - Design for Assembly (DFA).

TOTAL:45 PERIODS

OUTCOMES:

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

- Understand the various design requirements and processes involved in product development.
- Be exposed to various creativity and problem solving techniques.

TEXT BOOK:

1. George E.Dieter, "Engineering Design: A Materials and Processing Approach" 4th Edition, Tata McGraw Hill, 2008.

REFERENCES:

1. Joseph E.Shigley, Charles R.Mische ,"Mechanical Engineering Design", McGraw Hill International edition, 6th Edition 2009.
2. Edward B.Magrab,Satyandra K. Gupta, F. Patrick McCluskey and Peter Sandborn, "Integrated Product and Process Design and Development", 2nd edition, CRC Press, 2009.
3. James Garratt," Design and Technology", 2nd Revised Edition, Cambridge University Press, 1996.

ME 7751 FINITE ELEMENT ANALYSIS L T P C
3 0 0 3

OBJECTIVES:

- To introduce the concepts of Mathematical Modeling and numerical solution of engineering problems.
- To appreciate the use of Finite Element Method to a range of engineering problems.

UNIT I INTRODUCTION 9

Historical Background – Mathematical Modeling of field problems in Engineering –Governing Equations – Discrete and continuous models – Boundary, Initial and Eigen Value problems– Weighted Residual Methods – Variational Formulation of Boundary Value Problems – Ritz Technique – Basic concepts of the Finite Element Method.

UNIT II ONE-DIMENSIONAL PROBLEMS 9

One Dimensional Second Order Equations – Discretization – Element types- Linear and Higher order Elements – Derivation of Shape functions and Stiffness matrices and force vectors- Assembly of Matrices - Solution of problems from solid mechanics including thermal stresses-heat transfer. Natural frequencies of longitudinal vibration and mode shapes. Fourth Order Beam Equation –Transverse deflections and Transverse Natural frequencies of beams.

UNIT III TWO DIMENSIONAL SCALAR VARIABLE PROBLEMS 9

Second Order 2D Equations involving Scalar Variable Functions – Variational formulation –Finite Element formulation – Triangular elements and Quadrilateral elements- Shape functions and element matrices and vectors. Application to Field Problems - Thermal problems – Torsion of Non circular shafts.

UNIT IV TWO DIMENSIONAL VECTOR VARIABLE PROBLEMS 9

Equations of elasticity – Plane stress, plane strain and axisymmetric problems – Constitutive matrices and Strain displacement matrices – Stiffness matrix – Stress calculations - Plate and shell elements.

UNIT V ISOPARAMETRIC FORMULATION AND ADVANCED TOPICS 9

Natural co-ordinate systems – Isoparametric elements – Shape functions for isoparametric elements – One and two dimensions – Serendipity elements – Numerical integration - Matrix solution techniques – Solutions Techniques to Dynamic problems – Introduction to Analysis Software- Introduction to Non Linearity.

TOTAL:45 PERIODS

OUTCOMES:

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

- Understand the use of the FEM to solve problems in Mechanical Engineering.
- Use the Finite Element Method to solve Structural, thermal and Eigen value problems.

TEXT BOOKS:

1. J.N.Reddy, “An Introduction to the Finite Element Method”, 3rd Edition, Tata McGrawHill,2005
2. Seshu, P, “Text Book of Finite Element Analysis”, Prentice-Hall of India Pvt. Ltd., NewDelhi, 2007.

REFERENCES:

1. Logan, D.L., “A first course in Finite Element Method”, Thomson Asia Pvt. Ltd., 2002.
2. Robert D. Cook, David S. Malkus, Michael E. Plesha, Robert J. Witt, “Concepts and Applications of Finite Element Analysis”, 4th Edition, Wiley Student Edition, 2002.
3. Rao, S.S., “The Finite Element Method in Engineering”, 3rd Edition, Butter worth Heinemann, 2004.
4. Chandrupatla and Belagundu, “Introduction to Finite Elements in Engineering”, 3rd Edition, Prentice Hall, 1990.
5. David Hutton, “Fundamentals of Finite Element Analysis” McGrawHill, 2005
6. Dhanaraj. R and Prabhakaran Nair. K, “Finite Element Analysis”, Oxford Publications, 2015.

MF7071 ADDITIVE MANUFACTURING TECHNOLOGY L T P C

3 0 0 3

OBJECTIVES:

- To know the principle, methods, possibilities and limitations as well as environmental effects of Additive Manufacturing technologies.
- To be familiar with the characteristics of the different materials those are used in Additive Manufacturing technologies.

UNIT I INTRODUCTION 9

Overview – Need - Development of Additive Manufacturing Technology -Principle –AM Process Chain- Classification –Rapid Prototyping- Rapid Tooling – Rapid Manufacturing – Applications- Benefits –Case studies.

UNIT II DESIGN FOR ADDITIVE MANUFACTURING 9

Design tools: Data processing - CAD model preparation – Part orientation and support structure generation – Model slicing –Tool path generation- Design for Additive Manufacturing: Concepts and objectives- AM unique capabilities – DFAM for part quality improvement- Customised design and fabrication for medical applications.

UNIT III PHOTOPOLYMERIZATION AND POWDER BED FUSION PROCESSES 9

Photo polymerization: SLA-Photo curable materials – Process - Advantages and Applications. Powder Bed Fusion: SLS-Process description – powder fusion mechanism – Process Parameters – Typical Materials and Application. Electron Beam Melting.

UNIT IV EXTRUSION BASED AND SHEET LAMINATION PROCESSES 9

Extrusion Based System: FDM-Introduction – Basic Principle – Materials – Applications and Limitations – Bioextrusion. Sheet Lamination Process:LOM- Gluing or Adhesive bonding – Thermal bonding.

UNIT V PRINTING PROCESSES AND BEAM DEPOSITION PROCESSES 9

Droplet formation technologies – Continuous mode – Drop on Demand mode – Three Dimensional Printing – Advantages – Bioplotter - Beam Deposition Process:LENS- Process description – Material delivery – Process parameters – Materials – Benefits – Applications.

TOTAL: 45 PERIODS

OUTCOME:

- On completion of this course, students will learn about a working principle and construction of Additive Manufacturing technologies, their potential to support design and manufacturing, modern development in additive manufacturing process and case studies relevant to mass customized manufacturing.

TEXT BOOKS:

1. Ian Gibson, David W.Rosen, Brent Stucker “Additive Manufacturing Technologies: Rapid Prototyping to Direct Digital Manufacturing” Springer , 2010.
2. Chua C.K., Leong K.F., and Lim C.S., “Rapid prototyping: Principles and applications”, Third edition, World Scientific Publishers, 2010.

REFERENCES:

1. Liou L.W. and Liou F.W., “Rapid Prototyping and Engineering applications :A tool box for prototype development”, CRC Press, 2007.
2. Kamrani A.K. and Nasr E.A., “Rapid Prototyping: Theory and practice”, Springer, 2006.
3. Tom Page “Design for Additive Manufacturing” LAP Lambert Academic Publishing, 2012.
4. Andreas Gebhardt “Understanding Additive Manufacturing: Rapid Prototyping, Rapid Manufacturing” Hanser Gardner Publication 2011.

MF7651 NON-TRADITIONAL MACHINING PROCESSES L T P C
3 0 0 3

OBJECTIVE:

At the end of this course the students are expected to

- Understand the working principles of various non-traditional machining processes, their applications, advantages and limitations.
- The students can also able to learn advanced nano finishing processes, recent developments in the non-traditional machining processes and to compare them.

UNIT I INTRODUCTION AND MECHANICAL ENERGY BASED PROCESSES 9

Introduction to non-traditional machining processes, need for non-traditional machining, classification of non-traditional machining processes, their applications, advantages, limitations. Abrasive jet machining, abrasive water jet machining, ultrasonic machining their working principles, equipments, effect of process parameters, applications, advantages and limitations.

UNIT II CHEMICAL AND ELECTRO CHEMICAL ENERGY BASED PROCESSES 9

Chemical machining, electro-chemical machining, electro-chemical honing, electro-chemical grinding, electro-chemical deburring their working principles, equipments, effect of process parameters, applications, advantages and limitations.

UNIT III THERMO-ELECTRIC ENERGY BASED PROCESSES 9

Electric discharge machining, wire electric discharge machining, laser beam machining, plasma arc machining, electron beam machining, Ion beam machining their working principles, equipments, effect of process parameters, applications, advantages and limitations.

UNIT IV ADVANCED NANO FINISHING PROCESSES 9

Abrasive flow machining, chemo-mechanical polishing, magnetic abrasive finishing, magneto rheological finishing, magneto rheological abrasive flow finishing their working principles, equipments, effect of process parameters, applications, advantages and limitations.

UNIT V RECENT TRENDS IN NON-TRADITIONAL MACHINING PROCESSES 9

Recent developments in non-traditional machining processes, their working principles, equipments, effect of process parameters, applications, advantages and limitations. Comparison of non-traditional machining processes.

TOTAL: 45 PERIODS

OUTCOMES:

At the end of this course the students are expected to understand

- The working principles of various non-traditional machining processes, their applications, advantages and limitations.
- Advanced nano finishing processes.
- Recent developments in the non-traditional machining processes.
- Comparison of non-traditional machining processes.

TEXT BOOKS:

1. M. Adithan, “Unconventional Machining Processes”, Atlantic, New Delhi, 2009.
2. V. K. Jain, “Introduction to Micromachining”, Narosa publishing House, New Delhi, 2014.

REFERENCES:

1. V. K. Jain, “Advanced Machining Processes”, Allied Publishers Pvt. Ltd., New Delhi, 2002.
2. Serope Kalpakjian and Steven R. Schmid, “Manufacturing Engineering and Technology”, Prentice Hall, 2013.
3. Serope Kalpakjian and Stevan R. Schemid, “Manufacturing Processes for Engineering Materials”, Pearson Education, 2008.
4. Brahem T. Smith, “Advanced machining”, I.F.S., U.K, 1989.
5. Benedict, G.F., “Non-traditional Manufacturing Processes”, Marcel Dekker Inc., New York 1987.
6. Pandey P.C. and Shan H.S., “Modern Machining Processes”, Tata McGraw Hill, New Delhi,1980.
7. Metals Handbook, Vol. 3, Machining, American Society for Metals, Metals Park, USA.

ML7001	BIO AND SMART MATERIALS	L	T	P	C
		3	0	0	3

OBJECTIVE

- To study applications of materials in biomedical engineering and special materials for actuators, sensors, etc.

UNIT I INTRODUCTION 9

Intelligent / Smart materials – Functional materials – Polyfunctional materials – Structural materials, Electrical materials, bio-compatible materials. – Intelligent biological materials – Biomimetics – Wolff's Law – Biocompatibility – Material response: swelling and leaching, corrosion and dissolution, deformation and failure, friction and wear – host response: the inflammatory process – coagulation and hemolysis – in vitro and in vivo evaluation of biomaterials.

UNIT II ELECTRO-RHEOLOGICAL AND PIEZOELECTRIC MATERIALS 9

The principal ingredients of smart materials –microsensors- hybrid smart materials - an algorithm for synthesizing smart materials – active, passive reactive actuator based smart structures- suspensions and electro-rheological fluids - Bingham body model – principal characteristics of electro-rheological fluids – charge migration mechanism for the dispersed phase – electro- rheological fluid domain – fluid actuators- design parameter – application of Electo-rheological fluids – Basics, Principles and instrumentation and application of Magnetorheological fluids – Piezoelectric materials: polymers and ceramics, mechanism, properties and application. Introduction to electro-restrictive and magneto-restrictive materials

UNIT III SHAPE MEMORY MATERIALS 9

Nickel – Titanium alloy (Nitinol) – Materials characteristics of Nitinol – martensitic transformations – austenitic transformations – thermoelastic martensitic transformations– classification of SMA alloys- mechanism of magnetic SMA – applications of SMA – continuum applications of SMA fasteners – SMA fibers – reaction vessels, nuclear reactors, chemical plant, etc. – micro robot actuated by SMA – SMA memorization process (Satellite Antenna Applications) SMA blood clot filter – Impediments to applications of SMA – Shape memory polymers– mechanism of shape memory-Primary moulding – secondary moulding– types and applications.

UNIT IV ORTHOPAEDIC AND DENTAL MATERIALS 9

Bone and teeth composition, formation and properties – bioresorbable, bioinert, bioactive materials - temporary fixation devices – joint replacement – biomaterials used in bone and joint replacement metals and alloys- Fillings and restoration materials – Materials for oral and maxillofacial surgery – dental cements and dental amalgams – dental adhesives- bone tissue engineering.

UNIT V APPLICATIONS OF BIO MATERIALS FOR CARDIOVASCULAR OPTHALMOLOGY AND SKIN REGENERATION 9

Blood clotting – blood theology– approaches to thrombo resistance materials development– blood vessels – The heart – aorta and valves – geometry of blood circulation – cardiac pacemakers – blood substitutes – extracorporeal blood circulation devices.The lungs – vascular implants: vascular graft, cardiac valve prostheses, card– Biomaterials in opthalmology –skin grafts -connective tissue grafts – tissue adhesives – drug delivery methods and materials.

TOTAL: 45 PERIODS

OUTCOMES

- Use of Bio materials for cardiovascular Opthalmology and Skin Regeneration
- Use of Bio materials for Dental & Bone application
- Use of shape memory alloys in engineering application
- Explain the characteristics of Bio and smart materials
- Use of smart materials as sensors, actuators.

TEXTBOOKS

1. Sujata V., Bhat., "Biomaterials", Narosa Publication House, New Delhi, 2002
2. M. V. Gandhi and B. S. Thompson, "Smart Materials and Structures", Chapman and Hall, London, First Edition, 1992.

REFERENCES

1. Duerig,T. W., Melton, K. N, Stockel, D. and Wayman, C.M., "Engineering aspects of Shapememory Alloys", Butterworth – Heinemann, 1990.
2. Rogers, C. A., Smart Materials, "Structures and Mathematical issues", Technomic Publishing Co., U.S.A, 1989
3. Mohsen Shahinpoor and Hans-Jo¨rg Schneider "Intelligent Materials", RSC Publishing,2008
4. Mel Schwartz (Ed), Encyclopaedia of Smart Materials" Volume –I and II, John Wiley & Sons, Inc.2002
5. Buddy D. Ratner (Editor), Allan S. Hoffman (Editor), Frederick J. Schoen (Editor), Jack E. Lemons, "Biomaterials Science: An Introduction to Materials in Medicine", Academic Press,2nd edition, 2004

ML7002	CASTING PROCESSES	L	T	P	C
		3	0	0	3

OBJECTIVE

- Metal casting is one of the important manufacturing processes used for manufacturing components, the content of the syllabus focuses on imparting knowledge on casting practices of Alloy steels, Magnesium, Aluminium, Zinc and Copper alloys.

UNIT I MAGNESIUM ALLOYS 9

Introduction to different types of Magnesium alloys – Process for Manufacturing Magnesium alloys – Production considerations – Die casting consideration – die life productivity – applications of Magnesium alloy cast parts

UNIT II ALUMINIUM ALLOYS 9

Introduction to different types of Aluminium alloys – Process for Manufacturing Aluminium alloys - Production considerations – die life – productivity – applications of Aluminium Cast Parts.

UNIT III ALLOY STEELS 9

Introduction to different types of Alloy steels – process for manufacturing alloy steels – production considerations – productivity – applications of alloy cast parts.

UNIT IV ZINC ALLOYS 9

Introduction to different types of Zinc alloys – process for manufacturing Zinc alloys – production considerations – Die casting considerations – die life – productivity – applications of Zinc alloys cast parts.

UNIT V COPPER ALLOYS 9

Introduction to different types of copper alloys. Process for manufacturing copper alloys production considerations. Die casting considerations – die life – productivity – applications of copper alloys cast parts.

TOTAL: 45 PERIODS

OUTCOMES

- Ability to design casting process for alloys, such as Magnesium and Aluminum, Steel, Zinc, copper and its alloy.
- Ability to perform die life calculation, productivity

TEXTBOOKS

1. Jain, P. L., "Principles of Foundry Technology", 4 th edition Tata McGraw Hill, 2008.
2. Heine, R. W, Loper, C. R. and Rosenthal, "Principles of Metal Casting", McGraw Hill, New Delhi, 2010.

REFERENCES

1. A.K. Chakrabarti "Casting Technology and Cast Alloys" Prentice Hall of India Limited 2005
2. ASM Hand Book Vol. 5 Casting, ASM International, 1998.
3. Ramana Rao, T. V., "Metal Casting Principles and Practice", 1st edition, New Age International, 1996.

ML7003 COMPUTER APPLICATIONS IN MATERIALS SCIENCE L T P C
3 0 0 3

OBJECTIVE

- Computer applications have become important to solve, approximate, interpret and visualize problems in Materials Science. After reviewing the mathematical foundation, applications in Materials Science are introduced.

UNIT I SOLUTIONS OF EQUATIONS AND INTERPOLATION 9

Application for the fitting and interpolation of experimental data in Materials Science Roots of equations – Methods of bisection and false position – Newton-Raphson method– Simultaneous equations – Gauss elimination – Gauss Jordan method - Newton's and Langrange's interpolation methods.

UNIT II PARTIAL DIFFERENTIAL EQUATIONS 9

Applications in diffusion and mass transport in materials.

Type of equations – Elliptic equations – Laplace's equation – Hyperbolic equations – Wave equations – The Lax method – Eulerian and Lagrangian methods - Parabolic Equations – Diffusion – The Dufort-Frankel Method – Conservative methods – The Equation of continuity– The Diffusion equations.

UNIT III MONTE CARLO METHODS AND SIMULATION 9

Monte Carlo Method for simulating nucleation and growth of grains in materials.

Monte Carlo – Random Number Generators – Monte-Carlo Integration – The Metropolis Algorithm – Thermodynamic Averages – Quantum Monte-Carlo – Molecular Dynamics – General Principles.

UNIT IV MATRIX ALGEBRA 9

Study of anisotropy in materials.

Introduction – types of matrix– simple matrix problems – elliptic equations – Poisson's equation– systems of equations and matrix inversion – Exact Methods – Iterative Methods - The Jacobi Method – The Gauss-Seidel Method – Matrix Eigen value Problems – Schrödinger's equation– Full and Partial Diagonalisation - Sturm Sequence.

UNIT V SELECTED APPLICATIONS IN MATERIALS SCIENCE 9

Modeling and property Prediction.

TOTAL: 45 PERIODS

OUTCOME

- Ability to use computational techniques the Materials Engineering
- Use of mathematical equation to predict the properties of materials

TEXTBOOKS

1. Venkatraman, M. K., "Numerical Methods in Science and Engineering", National Publishing Company, Madras, 1996.
2. Sastry, S. S.," Introductory Methods of Numerical Analysis", Prentice Hall of India, New Delhi, 1992.

REFERENCES

1. Samuel S M Wong,"Computational Methods in Physics and Engineering", 2nd Edition
2. Wilkinson J H," The Algebraic Eigenvalue Problem", Clarendon Press Oxford, 1964.
3. Chandra. S.,"Computer Applications in Physics: with Fortran, Basic and C", Narosa Publications 2nd edition, 2006
4. Brenner, D. W.," Computer Applications in Materials Science and Engineering", John Wiley & Sons, 2007.
5. Julian, Maureen M., "Foundations of crystallography with computer applications", CRC, 1st edition, 2008
6. Ghosh Dastidar, P. S., "Computer Simulation of Flow and Heat Transfer", Tata McGraw Hill, New Delhi, 1998

ML7004 CREEP AND FATIGUE BEHAVIOUR OF MATERIALS L T P C

3 0 0 3

OBJECTIVE

- The useful life of components is often limited by the fracture, fatigue and creep properties of the materials used. The students study the fundamental processes leading to failure of technical components.

UNIT I INTRODUCTION

Strength of perfect crystal - Lattice resistance to dislocation movement – Elastic properties of dislocation – Dislocation multiplication – Slip and twinning in crystalline solid.

UNIT II HIGH – TEMPERATURE DEFORMATION RESPONSE 9

Creep Of Solids – Temperature stress – Strain rate relation- Deformation mechanism – Super plasticity deformation mechanism maps – Extrapolation procedure for creep rupture data – materials for elevated temperature rules.

UNIT III CYCLIC STRESS AND STRAIN FATIGUE 9

Macro fractrography fatigue failures - cyclic stress and strain controlled fatigue - Fatigue life estimation for notched components – Crack initiation mechanisms.

UNIT IV FATIGUE CRACK PROPAGATION 9

Stress and crack lengths correlations with FCP – Fracture modes in Fatigue – Microscopic fracture mechanisms – Crack growth behavior at Δk extremes – Influences – Micro structural aspects of FCP in metal alloys.

UNIT V ANALYSIS OF ENGINEERING FAILURES 9

Typical defects – Microscopic surface examination – metallographic and fractographic examination – Component failure analysis – Fracture surface preservation – Cleaning and replication techniques and image interpretation.

TOTAL: 45 PERIODS

OUTCOMES

- Identify the fracture due to creep and fatigue
- Use of suitable mathematical equation to predict ability the crack growth rate
- Ability to perform failure analysis

TEXTBOOKS

1. Richard. W. Hertzberg," Deformation and Fracture Mechanism of Engineering Materials", John Willey and Sons, 4th edition, 1996.
2. Anderson, T. L.," Fracture Mechanics: Fundamentals and Applications", CRC Press, 2nd edition, 1995.

REFERENCES

1. Courtney, T. H.," Mechanical Behaviour of Materials", McGraw-Hill, 1990
2. Jones, D. R. H," Engineering Materials 3, Materials Failure Analysis- Case Studies and Design Implications", Pergamon, 1993.
3. Hull & Bacon "Introduction to Dislocations", 3rd ed., Pergamon Press, 1984.
4. Frost & Ashby, "Deformation - Mechanism Maps", 1st ed., Pergamon Press, 1982.
5. Suresh, S.," Fatigue of Materials", Cambridge University Press, 2 nd edition, 1998.
6. Ashok Saxena," Nonlinear Fracture Mechanics for Engineers", CRC Press, 1998.
7. Cadek, J.," Creep in Metallic Materials", Elsevier, 1988.

ML7005 CRYOGENIC TREATMENT OF MATERIALS

L	T	P	C
3	0	0	3

OBJECTIVE

- Students are to study and become familiar with this very specialized form of material treatment at low temperature.

UNIT I INTRODUCTION 9

Insight on Cryogenics-Basics, Properties of Cryogenic fluids, Liquefaction Cycles - Carnot Liquefaction Cycle, F.O.M. and Yield of Liquefaction Cycles. Inversion Curve – Joule Thomson Effect. Linde Hampson Cycle, Precooled Linde Hampson Cycle, Claude Cycle, Dual Cycle.

UNIT II CRYOCOOLERS 9

Cryocooler requirement- Satellite communication, Surveillance Imaging, Military applications, Impact of regenerative materials on cooler performance, Impact of material properties on cryocooler performance-Materials used, Thermal Properties, Electrical Properties, and Mechanical properties.

UNIT III CRYOGENIC PROCESSING 9

Historical Development of Cryogenic Treatment, Cryogenic for Ferrous Metals, Need for cryogenic treatment, Types of low temperature treatment and processors, Benefits of cryogenic treatment-Wear resistance, Stress Relieving, Hardness Precautions during cryogenic treatment.

UNIT IV MATERIALS ENGINEERING 9

Desirable qualities for materials used in cryogenic applications, History and applications of metallic / non-metallic materials, Understanding properties and fabrication processes of superconducting Nb3Sn wires, High temperature superconductors. Characterization of cryogenically processed materials.

UNIT V APPLICATIONS 9

Cryogenic processing of materials for Space applications, Superconductivity, Medical applications, Food Preservation-Individual Quick Freezing, Tool Industry, Automobiles etc.

TOTAL: 45 PERIODS

OUTCOME

- Ability to perform cryogenic treatment of materials
- Ability to select materials for cryogenic treatment
- Discuss the properties and application after cryogenic treatment of materials

TEXTBOOKS

1. Randall F. Barron, “Cryogenic Systems”, McGraw-Hill, 1985.

REFERENCES

1. William E. Bryson, “Cryogenics”, HanserGardner Publications,1999.
2. Klaus D. Timmerhaus and Richard P. Reed, “Cryogenic Engineering”, Springer, 2007.
3. Scott R. B., “Cryogenic Engineering”, Van Nostrand and Co., 1962.
4. Jha, A. R., “Cryogenic Technology and Applications”, Butterworth-Heinemann, 2006

ML7006	ELECTRON MICROSCOPY AND DIFFRACTION ANALYSIS OF MATERIALS	L	T	P	C
		3	0	0	3

OBJECTIVE

- The characterization of sub-micron to nano-structured materials to reveal the structure-property- correlation involves electron microscopy and thereby diffraction analysis of materials. The course provides an in-depth understanding of the crystal structure and symmetry elements, diffraction theory and analysis as well as spectroscopy and electron microscopy.

UNIT I BASICS OF CRYSTALLOGRAPHY AND ELECTRON OPTICS 9

Introduction – Electron Optics – microscopy and the concept of resolution – interaction of electrons with matter – depth of field and depth of focus, crystallography – symmetry elements – symmetry operations, point groups, space groups, indexing planes, indexing lattice directions – plane normals – zones and the zone law, stereographic projection – Wulff Net

UNIT II ELECTRON DIFFRACTION THEORY 9

Basics of electron diffraction – scattering by an individual atom, scattering by a crystal – Bragg law – Laue conditions, reciprocal lattice and diffraction by a single crystal – Ewald sphere construction, elastic scattering, inelastic scattering, Structure Factor, intensity distribution in reciprocal space - standard spot patterns

UNIT III TRANSMISSION ELECTRON MICROSCOPES 9

Working principle of TEM – important aspects of microscope operation and alignment – aberration correction – resolution, formation of diffraction patterns and images – SAED – bright and dark field images – Centered dark field images - weak beam images – sample preparation, advanced TEMs – HRTEM

UNIT IV DIFFRACTION ANALYSIS 9

Types of diffraction patterns – ring pattern – spot pattern – Kikuchi pattern, indexing diffraction patterns – spots/ kikuchi lines produced by planes in one zone – spots/ kikuchi lines arising from different zones – imperfect patterns – kikuchi maps – Electron Back Scattered Diffraction Pattern (EBSD), standard spot patterns, uniqueness in indexing diffraction patterns - 180° ambiguity, usage of electron diffraction patterns – orientation relationship determination – second phase identification – defect analysis, other diffraction spots – extra spots, satellite spots and streaks – identification of materials

UNIT V SCANNING ELECTRON MICROSCOPES 9

Working principles of SEM, depth of field (focus), interaction volume, secondary electrons, backscattered electrons, Spectroscopy – Energy Dispersive X-ray spectroscopy – wavelength dispersive X-ray spectroscopy – Electron energy loss spectroscopy, microscope operation – imaging – sample preparation, advanced SEMs – Scanning Transmission Electron Microscope (STEM)

TOTAL: 45 PERIODS

OUTCOME

- The student will able to interpret characterization results of diffraction pattern and images of electron microscopy, so as to identify phase, symmetry, crystal structure, orientation, defects, etc and elemental composition bulk from X-ray spectroscopy and of surface from electron energy loss spectroscopy.

TEXTBOOKS

1. Peter J. Goodhew, John Humphreys, Richard Beanland, “Electron Microscopy and Analysis”, 3rd Edition, Taylor and Fransis, II New Fetter Lane, London, 2001.
2. David B. Williams and C. Barry Carter, “Transmission Electron Microscopy: A Text Book for Materials Science”, Publisher: Springer, USA, 2009.

REFERENCES

1. J. W. Edington, “Electron Diffraction in the Electron Microscope”, N. V. Philips’ Gloeilampenfabrieken, Eindhoven, 1975.
2. Joseph Goldstein, Dale Newbury, David Joy, et al., “Scanning Electron Microscopy and X-ray Microanalysis”, Kluwer Academic / Plenum Publishers, New York, 2003.
3. Marc De Graef, “Introduction to Conventional Transmission Electron Microscopy”, Cambridge University Press, UK, 2003.

ML7007 ENERGY STORING DEVICES AND FUEL CELLS

L	T	P	C
3	0	0	3

OBJECTIVE

- Traditional use of fuels for storage Load management, Space conditioning, Transportation, Utility system, Variable energy sources, Role of different energy forms, Energy quality, Energy efficiency, Energy and power densities.
- Ability to converse about the working of a typical fuel cell, its types and to elaborate on its thermodynamics and kinetics. Able to analyze the cost effectiveness and eco-friendliness of Fuel Cells

UNIT I BATTERY CHARACTERISTICS 9

Voltage, current, capacity, electricity storage density, power, discharge rate, cycle life, energy efficiency, shelf life. Primary batteries: The chemistry, fabrication, performance aspects, packing and rating of zinc-carbon, magnesium, alkaline, manganous dioxide, mercuric oxide, silver oxide batteries, zinc/air and lithium button cells- solid electrolyte cells.

UNIT II SECONDARY BATTERIES 9

The chemistry, fabrication and performance aspects and rating of lead acid and valve regulated (sealed) lead acid, nickel-cadmium, nickel-zinc, lithium and lithium ion batteries - Rechargeable zinc alkaline battery. Reserve batteries: Zinc-silver oxide, lithium anode cell, thermal batteries.

Batteries for electric vehicles: Metal/air, zinc-bromine, sodium-beta alumina and lithium/iron sulphide batteries. (outline only) Photogalvanic cells. Battery specifications for cars, heart pacemakers, computer standby supplies etc.

UNIT III FUEL CELLS 9

Introduction – relevance, importance and classification of fuel cells. Background theory - thermodynamic aspects of electrochemistry-energy conversion and its efficiency – factors affecting the efficiency, electrode kinetics of electrochemical energy conversion.

UNIT IV TYPES OF FUEL CELLS 9

Description, working principle, components, applications and environmental aspects of the following types of fuel cells: alkaline fuel cells, phosphoric acid, solid oxide, molten carbonate, direct methanol fuel cells. Proton Exchange Membrane fuel cells - basic aspects – working and high temperature operation – recent development in technology.

UNIT V HYDROGEN AS FUEL, SOLAR CELL AND ENVIRONMENT 9

Sources of hydrogen and preparation – clean up and storage – use as fuel in cells. Energy conversion devices, photovoltaic and photo electrochemical cells – photo biochemical conversion cell. Future prospects-renewable energy and efficiency of renewable fuels – economy of hydrogen energy – life cycle assessment of fuel cell systems.

TOTAL: 45 PERIODS

OUTCOME

- Course enable student to understand latest energy storage and fuel cell technology and designing principle related to energy efficiency.

TEXT BOOKS

1. Aulice Scibioh M.and Viswanathan B, “Fuel Cells – principles and applications’, University Press (India), 2006
2. Pletcher D and Walsh C,“Industrial Electrochemistry”, Blackie Academic and Professional, 1993.

REFERENCES

1. Christopher M A Brett, “Electrochemistry – Principles, Methods and Applications”, Oxford University, 2004.
2. Newman J S and Thomas -Alyea K.E. “Electrochemical systems” (3rd ed) Wiley, Hoboken, NJ 2004.
3. Hoogers G (Ed), “Fuel cell handbook” CRC, Boca Raton, FL 2003
4. Lindon David, “Handbook of Batteries”, McGraw Hill, 2002
5. Dell, Ronald M Rand, David A J, “Understanding Batteries”, Royal Society of Chemistry, 2001
6. Barbir F “PEM fuel cells: theory and practice” Elsevier, Burlington, MA 2005.

ML7008 FRACTURE MECHANICS AND FAILURE ANALYSIS

L	T	P	C
3	0	0	3

OBJECTIVES

- To introduce the basic concept of fracture mechanics and failure analysis
- Import knowledge on mechanics of fracture during static and dynamic loading
- Understanding the failure mechanism of creep rupture.
- Understand the mechanism of wear and corrosion and knowledge on prevention

UNIT I BASIC CONCEPTS IN FRACTURE MECHANICS 9

The geometry of stress and strain, elastic deformation, plastic and elasto-plastic deformation, Brittle fracture: Griffiths theory, Ductile fracture, Probabilistic aspects of fracture mechanics - Microstructure

UNIT II MECHANICS OF FRACTURE- STATIC LOADING 9

Elastic fields – Analytical solutions yielding near a crack front – Irwin’s approximation - plastic zone size – Dugdaale model – J integral and its relation to crack opening displacement. Strain energy release and stress intensity factor. Evaluation of fracture Toughness of different materials: size effect & control.

UNIT III FAILURE ANALYSIS OF FATIGUE FRACTURE 9

Fundamental sources of failures- Deficiency in design, Empirical Relation describing crack growth by fatigue – Life calculations for a given load amplitude – effects of changing the load spectrum – Effects of Environment. Micro-structural analysis of fatigue failures, some case studies in analysis of fatigue failures.

UNIT IV FAILURE ANALYSIS OF CREEP RUPTURE 9

Fracture at elevated temperature: Time dependent mechanical behavior, stress rupture, Microstructural changes during creep, Mechanism of creep deformation and Creep deformation maps, Prediction of time to rupture, Creep-fatigue interaction. Some case studies in analysis of creep failures.

UNIT V FAILURE ANALYSIS OF CORROSION AND WEAR 9

Types of corrosion, Corrosion stress, corrosion cracking, Analysis of corrosion failure. Procedure for analysis of stress corrosion cracking. Effect of Environment. Analysis of corrosion characteristics of metals and alloys in different environment. Types of wear, Role of friction, Interaction of corrosion and wear. Analysis of wear failure.

TOTAL: 45 PERIODS

OUTCOME

- Ability to design structure to prevent failure from the internal defect that unit within the structure
- Ability to design structure to prevent fatigue and creep
- Ability to define different deformation and related theories
- Ability to analyse the corrosion and wear failure and system methods to prevent corrosion and wear.

TEXT BOOKS

1. Hertz berg R W, "Deformation and fracture mechanics of Engineering materials" second edition John Wiley sons inc, New York 1983.
2. Knott. J.F, "Fundamentals of Fracture Mechanics" Butterworth London, 1973.

REFERENCES

1. Evalds H L and RJH Warnhil, "Fracture Mechanics", Edward Arnold Ltd, Baltimore,1984.
2. Campbel J E, Underwood J H, and Gerberich W W., "Applications of Fracture Mechanics for the selection of Materials ", American Society for Metals, Metals Park Ohio, 1982.
3. Fracture Mechanics Metals Handbook, ninth edition, vol. 8 437-491, American Society of Metals Metal Park ohio, 1985
4. Kare Hellan,"Introduction of Fracture Mechanics", McGraw-Hill Book Company, 1985.
5. Prashant Kumar, "Elements of Fracture Mechanics", Wheeler Publishing,1999.

ML7009 FUELS, FURNACES AND REFRACTORIES

L	T	P	C
3	0	0	3

OBJECTIVE

- Many industries require process heat in the production and treatment of materials.
- This course teaches fundamentals and applications of fuels, furnaces sand Refractories.

UNIT I FUNDAMENTALS **9**

Thermal Energy, conversion. Heat Transfer, conduction, radiation, convection. Thermoelectric effect. thermocouples, Peltier effect. Temperature measurement.

UNIT II FUELS **9**

Thermal Energy conversion. Fossil fuels, availability, deposits, calorific content. Nuclear Fuels, Solar and geothermal heating.

UNIT III FURNACES **9**

Firing, electric Resistance, Radiation, Induction. Temperature control - PID. Multi zone furnaces. Batch and tunnel furnaces.

UNIT IV REFRACTORIES **9**

Heat resistant materials in steel making and non ferrous production plants. Applications in the power, energy conversion, petroleum and chemical industries.

UNIT V ADVANCED ISSUES **9**

Energy and Environment, Environmental optimization, Recycling of thermal energy. Emissions control.

TOTAL: 45 PERIODS

OUTCOME

- Use of different fuels for energy generation system
- Use of Refractories in furnace
- Ability to discuss the issues in environmental.

TEXT BOOKS

1. Gupta. O. P., “Elements of Fuels, Furnaces and Refractories”, 4th edition, Khanna Publishers, New Delhi, 2000.
2. Nandi, D. N., “Handbook on Refractories”, Tata McGraw-Hill, 1987.

REFERENCES

1. Yeshvant V. Deshmukh, “Industrial Heating: Principles, Techniques, Materials, Applications, and Design”, CRC Press, 2005
2. Gilchrist, J. D., “Fuels, Furnaces and Refractories”, Pergamon Press, 1977.

ML7010 INDUSTRIAL TRIBOLOGY

L	T	P	C
3	0	0	3

OBJECTIVE

- To introduce and expose students to the field and fundamentals in tribology and its applications.

UNIT I SURFACES AND FRICTION 9

Topography of Engineering surfaces- Contact between surfaces - Sources of sliding Friction– Adhesion-Ploughing- Energy dissipation mechanisms Friction Characteristics of metals - Friction of non metals. Friction of lamellar solids - friction of Ceramic materials and polymers- Rolling Friction - Source of Rolling Friction – Stick slip motion - Measurement of Friction.

UNIT II WEAR 9

Types of wear - Simple theory of Sliding Wear Mechanism of sliding wear of metals - Abrasive wear – Materials for Adhesive and Abrasive wear situations - Corrosive wear - Surface Fatigue wear situations - Brittle Fracture - wear - Wear of Ceramics and Polymers - Wear Measurements.

UNIT III LUBRICANTS AND LUBRICATION TYPES 9

Types and properties of Lubricants - Testing methods - Hydrodynamic Lubrication – Elasto- hydrodynamic lubrication- Boundary Lubrication - Solid Lubrication- Hydrostatic Lubrication.

UNIT IV FILM LUBRICATION THEORY 9

Fluid film in simple shear - Viscous flow between very close parallel plates - Shear stress variation Reynolds Equation for film Lubrication - High speed unloaded journal bearings - Loaded journal bearings – Reaction torque on the bearings - Virtual Co-efficient of friction - The Sommerfield diagram.

UNIT V SURFACE ENGINEERING AND MATERIALS FOR BEARINGS 9

Surface modifications - Transformation Hardening, surface fusion - Thermo chemical processes – Surface coatings - Plating and anodizing - Fusion Processes - Vapour Phase processes - Materials for rolling Element bearings - Materials for fluid film bearings - Materials for marginally lubricated and dry bearings.

TOTAL: 45 PERIODS

OUTCOME

- Ability to design friction, wear and Lubrication
- Ability to identify different types of sliding & rolling friction, Wear and related theories
- Ability to distinguish among the different Lubricant regime.
- Select materials for bearing.

TEXT BOOKS

1. A. Harnoy. "Bearing Design in Machinery "Marcel Dekker Inc, New York, 2003.

REFERENCES

1. M. M. Khonsari & E. R. Booser, " Applied Tribology", John Willey &Sons, New York, 2001.
2. E. P. Bowden and Tabor.D., " Friction and Lubrication ", Heinemann Educational Books Ltd., 1974.
3. A. Cameron, "Basic Lubrication theory", Longman, U.K.., 1981.
4. M. J. Neale (Editor), "Tribology Handbook", Newnes. Butterworth-Heinemann, U.K., 1995.

ML7011 INTRODUCTION TO TRANSPORT PHENOMENA

L	T	P	C
3	0	0	3

OBJECTIVE

- The subject introduce the students about the fundamental fluid mechanics, flow and energy transfer, in order understand and analysis the transport phenomena occurs in casting, welding, energy storing /transferring devices, mineral processing, chemical processing etc.

UNIT I FLUID MECHANICS **9**

Properties of fluids such as density, viscosity and specific weight. Fluid statics - Pressure at a point - Pressure variations in horizontal and vertical directions - Concept of gauge and absolute pressure. Use of manometer for pressure measurements. Introduction to Hydrostatic Forces.

Energy Balance in Fluid Flow: Types of flow - continuity equation - Application to one dimensional problems. Derivation of Bernoulli's equation and Euler's equation - Examples illustrating the use of energy equation in metallurgical processes.

UNIT II INTERNAL AND EXTERNAL FLOW **9**

Classification of flow - Reynolds number - Laminar flow between parallel plates and circular pipes - Simple problems.

Pressure in Fluid Flow: Head loss due to friction -Darcy - Weisbach equation - flow through pipes - use of Moody diagram - Minor losses - Simple problems.

UNIT III CONDUCTION HEAT TRANSFER **9**

Steady state heat conduction - simple examples. Transient heat conduction - Systems with negligible internal resistance - Lumped heat analysis - Response time of a temperature measuring instrument - System with negligible surface resistance- heat flow in an infinitely thin plate (Semi infinite body) - System with finite surface and internal resistance - Chart solutions of transient heat conduction problems – Examples on Heat Treatment

UNIT IV CONVECTIVE HEAT TRANSFER 9

Forced and free convention - Boundary layer concept -velocity and thermal boundary layers (no derivation) - Simple problems - Flow over flat plate - laminar and turbulent boundary layers (no derivation) - Simple problems – Boundary layer development in a circular duct (no derivation) - Flow over cylinders and spheres-Simple problem-applications in metallurgical processes.

UNIT V RADIATION HEAT TRANSFER 9

Nature of thermal radiation, Concept of Black body, Emissive power – Gray body - Shape factor - Simple problems on Radiation heat transfer between surfaces. Introduction to Gas radiation.

Mass Transfer: Diffusion mass transfer. Simple problems using Fick's law of diffusion. Introduction to convective mass transfer-Introduction to computational fluid dynamics-software.

TOTAL: 45 PERIODS

OUTCOME

- This course enables the students apply the knowledge of fluid mechanics, mass transport with respect to temperature and pressure as specific to mineral processing, liquid metal – solidification, etc. of materials technology.

TEXT BOOKS

1. Kothandaraman C.P. and Rudramoorthy, R., "Basic Fluid Mechanics", New Age International Publishers, Chennai 1998
2. Sachdeva, R C," Fundamentals of Engineering Heat and Mass Transfer", New Age International Publishers, New Delhi, 1996.

REFERENCES

1. Kothandaraman C P , "Fundamentals of heat and Mass Transfer", second edition, New Age International Publishers, Chennai, 1997.
2. Byron Bird R, W E Shawart, "Transport Phenomena", John-Wiley & Sons Inc, 1994.
3. Robert, W Fox, "Introduction to Fluid Mechanics", John Wiley & Sons, New York, USA, 1994
4. Irving H Shames," Mechanics of Fluids", third edition, McGraw Hill Publishing Co., New York, 1992.

ML7012 LASER PROCESSING OF MATERIALS L T P C
3 0 0 3

OBJECTIVE

- To impart the knowledge about the principles of industrial lasers such as laser generation, mode selection, beam mechanisms, modifications and characteristics, types of lasers etc. Also to introduce the concepts of laser processing of materials which includes background of laser systems, process parameters, material considerations and specific applications.

UNIT I PRINCIPLES OF INDUSTRIAL LASERS 9

Principle of laser generation, optical resonators, laser modes- mode selection, line-broadening mechanisms, laser beam modifications and types of industrials lasers.

UNIT II THERMAL PROCESS- HEAT AND FLUID FLOW 9

Heat flow in the work piece: thick plate with point heat source, thin plate with line heat source, peak temperature and cooling rates Fluid flow in molten pool: continuity equation, navier-stokes equation and surface tension effects.

UNIT III LASER METALLURGY 9

Process microstructure- fusion zone, zone of partial melting, haz, discontinuities- porosity, cracking, lack of fusion, incomplete penetration and undercut.

UNIT IV LASER WELDING AND SURFACE MODIFICATIONS 9

Process mechanisms (Key hole and Plasmas) – operating characteristics – process variations – imperfections- industrial applications –recent developments Laser surface heat treatment, Laser surface melting- Glazing, Laser direct Metal deposition– Laser surface alloying, Laser surface cladding and Hard coatings, Laser physical vapour deposition and Laser shock peening.

UNIT V LASER MACHINING 9

Laser instrumentation for cutting and drilling – cut quality and process characteristics – methods of cutting – practical performance – process variations – industrial applications of Laser cutting and drilling

TOTAL: 45 PERIODS

OUTCOMES

- Discuss the Laser principles and use of it in processing of Engineering materials.
- Use of it for Welding and surface modification of different Engineering materials.
- Perform Machining using Laser.

TEXT BOOKS

1. Elijah kannatey-Asibu, Jr., "Principles of Laser Materials processing ", John Wiley & Sons, 2009
2. Jacques Perrière, Eric Millon, Eric Fogarassy, "Recent advances in laser processing of materials" Elsevier, 2006.

ML7013 MAKING AND METALLURGY OF STAINLESS STEELS L T P C
3 0 0 3

OBJECTIVE

- Products made out of various types of Stainless steels find extensive applications both in domestic and Industrial applications. The aim of this subject is to provide a comprehensive knowledge on various aspects of Stainless steel making, metallurgy, Properties and its applications.

UNIT I HISTORY AND EVOLUTION OF STAINLESS STEEL 9

Essential elements, evolution, development of alloys, selection of Stainless steels, Recent processing enhancements.

UNIT II CLASSIFICATION OF STAINLESS STEELS 9

Wrought and Cast Stainless steels – Ferritic, Martensitic, Austenitic, Cr-Ni-Mo Stainless steels, Precipitation Hardened, Duplex, Heat Resistant, Abrasive and Wear resistant steels- Composition, Metallurgy, Properties, Phase Diagrams, Fretting and Galling, Welding and Weldability of Stainless steels.

UNIT III MELTING AND SECONDARY REFINING OF STAINLESS STEELS 9

Raw Materials selection, Melting Furnaces (EAF, EIF), melt treatment, secondary refining –AOD, VOD, IOC converters processing, advantages and limitations.

UNIT IV CORROSION BEHAVIOUR OF STAINLESS STEELS 9

Atmospheric, aqueous, stress corrosion, cracking and Hydrogen Embrittlement, High Temperature corrosion, Corrosion of Cast stainless steels, PREN Index, Corrosion rate estimations- ASTM Practices.

UNIT V APPLICATIONS OF STAINLESS STEELS 9

Architecture and construction, Automotive and Marine systems, Petroleum, Chemical, Pulpand Paper Industries applications.

TOTAL: 45 PERIODS

OUTCOME

- The students will understand the production methodology of stainless steel making and also gain knowledge on the metallurgy of stainless steel making.

TEXTBOOKS

1. Jonathan Beddoes, J. Gordon Parr, “Introduction to Stainless Steels”, ASM International, 2000
2. Joseph R. Davis , “STAINLESS STEELS”, ASM International, 3rd print,--1999
3. John C. Lippold, Damien J. Kotecki, “Welding Metallurgy and Weldabiiity of Stainless steels”, Wiley and Sons, Edition 2005

REFERENCES

1. R.A. Lula, James Gordon Parr , “Stainless steels”, American Society for Metals, 1996.
2. Joseph R.Davis, “Alloy Digest Source Book: Stainless Steels”, ASM International,2000.
3. Source book on Stainless steels, American Society for Metals, 1976.
4. Donald Peckner, Irving Melvis Bernstein , “Hand Book of Stainless steels”, McGraw Hill, 1977.
5. Michael F. McGuire , “Stainless steels for Design Engineers”, ASM International,2008

ML7014 MATERIALS FOR AUTOMOTIVE APPLICATION L T P C
3 0 0 3

OBJECTIVE

- Knowledge on properties of engineering materials
- To select suitable materials for design
- Materials selection criteria for engine and transmission systems
- Different materials used for automotive structures.
- Different electronic materials for automotive applications

UNIT I ENGINEERING MATERIALS AND THEIR PROPERTIES 9

Classes of engineering materials - the evolution of engineering materials, Definition of materials properties, Displaying material properties using materials selection charts, Forces for change in materials selection and design, Materials and the environment-selection of materials for automotive, aerospace, marine and defence applications.

UNIT II BASIS OF MATERIAL SELECTION 9

Selection strategy, Attribute limits and Material indices, structural index Selection procedure: Design process - types of design, design requirements, Function, Material attributes, Shape and Manufacturing processes - Materials processing and design processes and their influence on design, Process attributes, Systematic process selection, Process selection diagrams, Process cost, Energy consumption for production, Material costs, Availability, Recyclability, Environmental consideration. Computer aided selection.

UNIT III MATERIALS FOR ENGINES AND TRANSMISSION SYSTEMS 9

Materials selection for IC engines: Piston, piston rings, cylinder, Engine block, Connecting rod, Crank shaft, Fly wheels, Gear box, Gears, Splines, Clutches.

UNIT IV MATERIALS FOR AUTOMOTIVE STRUCTURES 9

Materials selection for bearings, leaf springs, chasis & frames, Bumper, shock absorbers, wind screens, panels, brake shoes, Disc, wheels, differentials , damping and antifriction fluids, Tyres and tubes.

UNIT V ELECTRONIC MATERIALS FOR AUTOMOTIVE APPLICATIONS 9

Materials for electronic devices meant for engine control, ABS, Steering, Suspension, Sensors, anti-collision, Anti-fog, Head lamps.

TOTAL: 45 PERIODS

OUTCOMES

- Discuss different materials used for automotive component manufacturing.
- Select proper material for Automobile applications

TEXT BOOKS

1. Gladius Lewis, "Selection of Engineering Materials", Prentice Hall Inc. New Jersey USA, 1995.
2. Charles J A and Crane. F A. A., "Selection and Use of Engineering Materials", 3rd Edition, Butterworths, London UK, 1996.

REFERENCES

1. James A. Jacobs, Thomas F. Kilduff., "Engineering Materials Technology: Structure, Processing, Properties & Selection", Prentice Hall, USA, 1996.
2. ASM Handbook, "Selection of Materials Vol. 1 and 2", ASM Metals Park, Ohio. USA, 1991.
3. M F Ashby, "Materials Selection in Mechanical Design", third edition, Butterworth- Heineman, New York, 2005.
4. ASM Handbook. "Materials Selection and Design", Vol. 20- ASM Metals Park Ohio.USA, 1997.
5. Cantor," Automotive Engineering: Lightweight, Functional, and Novel Materials", Taylor & Francis Group, London, 2006

ML7015 METALLURGY OF TOOL MATERIALS L T P C
3 0 0 3

OBJECTIVE

- Tooling materials require special considerations in production and applications. Students will learn about the various heat treatment processes that can be applied to the conventional tool materials as well as the advanced tool materials.

UNIT I CLASSIFICATION AND MANUFACTURE OF TOOL STEELS 9

Classification – AISI system, selection of tool steels from the point of view of mechanical properties, Effect of alloying elements such as W, Mo, Ni, V, Ti etc., in Tool steels, Production techniques –problems in melting – powder metallurgy route, Refining methods like VAR, ESR– forming of tool steels.

UNIT II HEAT TREATMENT OF TOOL STEELS AND DEFECTS 9

HEAT TREATMENT AND METALLURGY OF W, S, O, A & D TYPE TOOL STEELS Water hardening tool steels, shock resistance tool steels, cold work tool steels-oil hardening, mediumalloy and high carbon-high Cr(O,A&D types): Constitution, classification of principal types,heat treatment process, hardenability, distortion characteristics, properties and application.

HEAT TREATMENT AND METALLURGY OF H, T, M, SPECIAL PURPOSE TOOL STEELS-Hot work tool steels, high speed tool steels, maraging tool steels, special purpose tool steels: constitution, classification of principal types, heat treatment process, specific requirements and applications.

UNIT III PROPERTIES, TESTING AND FAILURE OF TOOL STEELS 9

Mechanical properties of Tool steels with respect to applications – Elevated temperature properties – Microstructures –Carbide distribution –Coating thickness, micro hardness – Adhesion and Scratch resistance. Tool failures – material heat treatment, manufacturing processes and Operational factors.

UNIT IV ADVANCED TOOL MATERIALS 9

Sintered Tungsten Carbide tools – ISO classification, Uses of P, M, K,H,W, S, O, A ,T grades Cermet – ceramics, mixed and reinforced grades –WC, Al_2O_3, SiC , CBN, PCD, TaC, TiC, Solid Carbide tools – Manufacturing techniques, heat treatment and properties, Stellites, Cemented carbides, ceramic tools, Special purpose tool steels.

UNIT V SURFACE TREATMENTS AND COATINGS 9

Sulphidizing of tool steels – TiN coating by PVD, coating of Carbide tools –Mono and multilayer Coatings of TiC, TiN, Alumina and DLC by PVD and CVD processes.

TOTAL: 45 PERIODS

OUTCOME

- The students will gain knowledge on the classification of various tool materials and they will be exposed to the heat treatments that can be performed on the various tool materials and their effect on the properties and their performance

TEXTBOOKS

1. George Roberts, George Krauss, Richard Kennedy, "Tool Steels" 5th edition, ASM International,1998.
2. Payson, Peter – "Metallurgy of Tool Steels" – John Wiley & Sons, New York 1962

REFERENCES

1. Robert Wilson, "Metallurgy and Heat treatment of Tool Steels, McGraw Hill New York,1975
2. Joseph R. Davies – "Tool Materials", ASM International, 1995

ML7016	MICRO MACHINING AND FABRICATION	L	T	P	C
		3	0	0	3

OBJECTIVE

- To introduce the various types of micromachining processes and their Applications.

UNIT I INTRODUCTION 9

Introduction to micromachining process – Classification of micromachining and nanomachining processes – Molecular dynamics, principle of molecular dynamics simulation- potential energy function – Boundary condition – MD simulation procedure.

UNIT II MICROFABRICATION METHODS 9

Methods of Microfabrication – Maleno deposition – Electro discharge deposition, Chemical vapour deposition physical vapour deposition – Electro Chemical spark deposition – LIGA.

UNIT III MECHANICAL MICROMACHINING 9

Ultrasonic machining – Abrasive jet machining – Abrasive water jet machining, water jet machining – Beam energy micromachining – Electron beam machining, electro discharge machining, ion beam machining, focused ion beam machining.

UNIT IV MICROMACHINING AND NANO FUNCTIONING WITH ABRASIVE FLOW 9

Process- principle and description – Process Technology -Selection of machine -Effect of process parameter on performance – Mechanism of materials removal Magneto Rheological Nanofunctioning Process. Nano functioning – Smart Rheological fluids – Magneto Rheological polishing fluid – Rheological character is of MRP fluid – MRF process – MRAFF Process – MRJF process.

UNIT V HYBRID MICRO MACHINING 9

Chemical Mechanical polishing – Electro chemical spark micro machining – Electro discharge grinding – Electrolytic in process dressing – Application.

TOTAL: 45 PERIODS

OUTCOME

- The student will gain knowledge of material removal mechanism and technology of various types of micromachining processes and their applications.

TEXTBOOKS

1. V.K.Jain – Introduction to Micromachining – Narosa Publishing house 2010.

REFERENCES

1. Sami Franssito : Introduction to Micro fabrication – John wiley and sons.
2. Jain V.K. Advanced machining process, Allied Publisher, Delhi 2002.
3. Mohammed Gad-el-Hat: “The MEMS Hand book” CRC Press 2006.

ML7017 MODELING AND SIMULATION IN MATERIALS ENGINEERING

L	T	P	C
3	0	0	3

OBJECTIVE

Modeling and simulation are important tools in understanding physical effects in many technological applications. This course should enable students to use standard packages for modeling and simulation applicable to Materials Science and Engineering.

UNIT I INTRODUCTION TO MODELING AND MATHEMATICAL CONCEPTS 9

Mathematical modeling, physical simulation, advantages and limitations - Review of differential equations, numerical methods, introduction to FEM, FDM- Governing differential equations of elastic, plastic deformation, fluid flow and heat transfer – basic steps in FEM

UNIT II ONE DIMENSIONAL PROBLEMS 9

Classical Techniques in FEM – Weighted residual method – Galarkin and Ritz method – Coordinates and shape functions- Potential energy approach –– Assembly of stiffness matrix and load vector – Finite element equations – Quadratic shape functions – Applications to elastic deformation of bar, plane trusses and beam – steady state heat transfer.

UNIT III TWO DIMENSIONAL AND AXISYMMETRIC CONTINUUM 9

Triangular and quadrilateral elements – Natural co-ordinates – Isoparametric formulation- 2D shape functions - Element stiffness matrix – Force vector – Solution procedure, Gaussian elimination and Cholskey decomposition techniques - Axisymmetric formulation - Boundary conditions – Applications in 2D elastic deformation and heat transfer problems.

UNIT IV SOFTWARE PACKAGES 9

Introduction to standard software packages – General purpose FEA packages such as ANSYS, ABAQUS, NASTRAN etc. – Special purpose packages such as DEFORM, OPTIFORM, ProCAST, etc. - Applications of FEA in simulation of sheet metal and bulk forming, solidification of casting and weldment, Concepts of coupled analysis

UNIT V COMPUTER APPLICATIONS IN PHYSICAL METALLURGY 9

Use of computers for the construction of phase diagrams, Features of CALPHAD – Expert system for alloy design and selection of materials – computer applications in crystallography.

TOTAL: 45 PERIODS

OUTCOMES

- Apply numerical techniques to a variety of materials process including solidification, heat treatment, grain from the recovery stabilization
- Able to evaluate the capabilities and limitation of commercial software.

TEXT BOOKS

1. Reddy J. N., "An Introduction to Finite Element Method", McGraw-Hill International Student Edition, 1985.
2. AMIE, "Modeling of casting and welding process", Volume I & II, the Metallurgical society of AMIE, 1981&1983.

REFERENCES

1. Piwonoka T.S., Vollen V., Katgerman l., "Modeling of Casting, Welding, and Advanced Solidification Process", 4th edition, TMS-AIME, USA, 1993
2. Stocks G.M., Turchi P.E.A., "Alloy Modeling and Design", the Metals Society, AMIE, USA, 1994.
3. Trivedi R., Sekhar J.A., Majumudar J., "Principles of Solidification and Material Processing", Volume I&II, Oxford and IBH, New Delhi, 1989.
4. Cerjak H., "Mathematical Modeling of Weld Phenomenon-2", The Institute of Materials, 1995.
5. O. C. Zienkiewicz and R. L. Taylor, "The Finite Element Methods, Vol.1. The basic formulation and linear problems", Vol. 1, Butterworth Heineman, 5th Edition, 2000.

ML7018 NANOSTRUCTURED MATERIALS L T P C

3 0 0 3

OBJECTIVE

- To motivate the students to understand the evolution of nanomaterials in the scientific era and make them to understand different processing methods, properties of nanomaterials for the future engineering applications.

UNIT I INTRODUCTION TO NANOMATERIALS 9

Amorphous, Crystalline, microcrystalline, quasicrystalline and nanocrystalline materials-historical development of nanomaterials – Nanomaterials classification (Gleiter's Classification) – properly changes done to size effects, Hall – Petch, inverse Hall- Petch effects - polymeric nanostructures.

UNIT II ZERO DIMENSIONAL NANOMATERIALS 9

Nanoparticles – Properties – Processing – Liquid state processing - Sol-gel process, wet chemical synthesis – Vapour state processing – PVD, CVD, Aerosol processing, solid state processing – mechanical, mechanochemical synthesis – Application of nanoparticle. Quantum Dots – Quantum confinement – Pauli's Exclusion Principle – Processing – Optical lithography – MOCVD – Droplet epitaxy - Applications.

UNIT III ONE DIMENSIONAL NANOMATERIALS 9

Carbon nanotubes – Old and new forms of carbon – Structure of CNT and classification – Processing – Solid carbon based production techniques – Gaseous carbon based production technique - growth mechanisms – Applications.

Nanowire – processing – Laser ablation – Oxide assisted growth – carbo thermal reactions– Thermal evaporation – Temperature based synthesis – Electro spinning – Vapour–Solid growth (VS growth) - vapour – liquid – solid growth (VLS technique) – Applications.

UNIT IV SUPER HARD COATINGS AND BULk NANOSTRUCTURED MATERIALS 9

Superhard coating- types – characteristics – thermal stability- case studies (nc-TiN/a-Si_3N_4 coating) – Applications. Buck nanostructured materials - Equal Channel Angular pressing(ECAP) – High Pressure Torsion(HPT), Accumulative roll bending – Reciprocating extrusion- compression, cyclic close die forging – Repetitive corrugation and straightening – Grain refinement mechanisms

UNIT V CHARACTERIZATION OF NANOMATERIALS 9

Nano indentation – Types of nanoindenter – Force actuation-Displacement measurement-factors affecting nanoindentation- Atomic Force Microscope (AFM) – Scanning Tunneling Microscope (STM) – Electrostatic Force Mode (EFM) – Magnetic Force Mode (MFM) – Scanning near field microscopy (SNOM) Scanning Electron Microscope (SEM) – Transmission Electron Microscope (TEM).

TOTAL: 45 PERIODS

OUTCOME

- Ability to design nanostructure using Building blocks of Nanotechnology
- Ability to use OD, 1D, 2D nano building block to process bulk nano structures
- Use of difficult characterization techniques to study the Fundamental properties.

TEXTBOOKS

1. Carl C. Koch (ed.), NANOSTRUCTURED MATERIALS, Processing, Properties and Potential Applications, NOYES PUBLICATIONS, Norwich, New York, U.S.A.
2. Bhusan, Bharat (Ed), “Springer Handbook of Nanotechnology”, 2nd edition, 2007

REFERENCES

1. Mark Ratner and Daniel Ratner, “Nano Technology”, Pearson Education, New Delhi, 2003.
2. Charles P. Poole Jr., Frank J. Ownes, ‘Introduction to Nanotechnology”, Wiley Interscience, 2003.
3. G. Wilde, “Nanostructured Materials’, Elsevier, 2008
4. Bamberg, D., Grundman, M. and Ledentsov, N.N., “Quantum Dot Heterostructures”, Wiley, 1999.
5. G Timp (ed), “Nanotechnology”, AIP press/Springer, 1999.
6. K.A. Padmanabhan and S. Balasivanandha Prabu, ‘On the Origins of Conflict in the Experimental Results Concerning the Mechanical Properties of Ultra-Fine Grained and Nanostructured Materials: Effects of Processing Routes and Experimental Conditions‘, Adv.Mech.Properties and Deform. Mechanism of Bulk Nanostr.Mat, Trans Tech Publication,UK, ISBN-13::978-3-03785-105-0, pp.3-54,

ML7019 **PHASE TRANSFORMATIONS** **L T P C**
3 0 0 3

OBJECTIVE

- The students having been taught the fundamentals of thermodynamics, physical metallurgy and diffusion processes can undergo an in depth study of the various phase transformation processes that take place in metals and alloys.

UNIT I DIFFUSION MECHANISMS **9**

Basics of thermodynamic & kinetics: equilibrium - configurational entropy - free energy of mixing - miscibility gap – chemical potential. Diffusion – uphill diffusion – downhill diffusion – atomic mechanisms of diffusion, Fick's 1st and 2nd law – solution to the diffusion equation – error functions – application of the non-steady state diffusion, spinodal decomposition

UNIT II DIFFUSION CONTROLLED PHASE TRANSFORMATIONS **9**

Nucleation and growth - types of nucleation – concept of free energy during solidification – thermodynamics of homogeneous nucleation – critical nucleus size and critical free energy change – extension to heterogeneous nucleation – nucleation rate and growth rate – overall transformation rate, concept of activation energy – Arrhenius equation – Johnson-Mehl-Avrami equation, pearlitic transformations.

UNIT III DIFFUSIONLESS PHASE TRANSFORMATIONS **9**

Martensite transformation – definition – characteristic features of Martensitic transformation in steels – morphology of Martensite – lath and acicular martensite – crystallography of martensitic transformation – martensite in non-ferrous systems – thermoelastic martensite – shape memory effect – examples and applications of shape memory alloys.

UNIT IV PRECIPITATION REACTIONS **9**

Precipitation reaction – thermodynamic considerations, structure and property during ageing– sequence of ageing – formation of G-P zones and intermediate precipitates, theories of precipitation hardening – effect of time, temperature and alloy compositions – precipitation free zones, crystallographic aspects of transformation, coarsening kinetics.

UNIT V RECOVERY, RECRYSTALLISATION AND GRAIN GROWTH **9**

Cold working and hot working, recovery – polygonisation and dislocation movements in polygonisation, recrystallisation – effect of time, temperature, strain and other variables – mechanism of nucleation and growth, grain growth – grain growth law, geometrical collisions, preferred orientation, secondary recrystallisation.

TOTAL: 45 PERIODS

OUTCOME

- Student will able apply knowledge of physical metallurgy related to phase transformation of ferrous and non ferrous alloys, to understand heat treatment, material processing condition and service conditions.

TEXTBOOKS

1. Jena, A.K., and Chaturvedi, M., "Phase Transformations in Materials", Prentice-Hall, 1993.
2. David A. Porter, Kenneth E. Easterling, Mohamed Y. Sherif, "Phase Transformations in Metals and Alloys", CRC Press, New York, 3rd edition, 2009.

REFERENCES

1. Romesh C. Sharma, "Phase Transformation in Materials", CBS Publishers & Distributors, New Delhi, 2002.
2. Reed Hill. R. E., "Physical Metallurgy Principles", Affiliated East West Press, New Delhi, 1992.
3. Anil Sinha, "Physical Metallurgy Handbook", McGraw-Hill Professional; 1st edition, 2002.

ML7020 PRINCIPLES OF METAL CUTTING

L	T	P	C
3	0	0	3

OBJECTIVE

- To learn about metal cutting operations from the theoretical and practical perspective.

UNIT I CUTTING TOOL NOMENCLATURE 9

Single point tool-significance of the various angles - Machine reference system- normal toll reference system- ORS – interrelation between different tool nomenclatures - Nomenclature of drills, milling cutters and broaches

UNIT II CHIP FORMATION MECHANISM AND FORCES IN MACHINING 9

Orthogonal and oblique cutting - Mechanisms of formation of chips-types of chips - Merchant's circle diagram-Force and Velocity relationship, shear plane angle, Energy considerations in matching-Ernst Merchant's theory of shear angle relationship - Forces in turning, drilling, milling and grinding- specific cutting pressure-specific horse power-construction and principle of operation of tool dynamometers for turning, drilling and milling.

UNIT III THERMAL ASPECTS IN MACHINING, TOOL WEAR AND LIFE 9

Sources of heat generation in machining heat in PSDZ and SDZ – heat flow in cutting tools temperature measurement techniques in machining, Functions of cutting fluid - characteristics of cutting fluid-types - application of cutting fluids - Tool wear, type of tool failure - mechanisms, tool life equation- tool life analysis - machinability - chatter in machining.

UNIT IV CUTTING TOOL MATERIALS 9

Requirements of tool materials-properties of HSS - advances in tool materials- carbides and coated carbides, ceramic, cermets, CBN, Diamond, PCD - ISO-specifications for inserts and tool holders - -Need for chip breakers – types of chip breakers

UNIT V MODELING OF METAL CUTTING 9

Introduction to modeling – empirical models – mechanistic models – FEA based models –artificial intelligence based models for turning, milling and drilling

TOTAL: 45 PERIODS

OUTCOME

- The course will enable a student to gain practical knowledge on the metal cutting operations and design of cutting tool.

TEXT BOOKS

1. Kuppuswamy, G., "Principals of Metal Cutting", Universities Press Limited, Hyderabad, 1996.
2. Bhattacharya, "Metal Cutting Theory and Practice ", Central Book Publishers, Calcutta, 1984.

REFERENCES

1. Edward M. Trent and Paul K. Wright "Metal Cutting" Butterworth-Heinemann; 4th edition 2000.
2. Boothroyd, G., "Fundamentals of Metal Machining and Machine Tools", McGraw-Hill Co., 1975.
3. Sadasiavm, T.A. and Sarathy, D., "Cutting tools for productive machining" WIDIA India limited, Bangalore, 1999.
4. Milton C. Shaw," Metal Cutting Principles", Oxford University Press, 2nd edition 2004.

ML7021 RELIABILITY CONCEPTS IN ENGINEERING

L	T	P	C
3	0	0	3

OBJECTIVE

- To impart knowledge in reliability concepts, reliability estimation methods and reliability improvement methods

UNIT I RELIABILITY CONCEPT **9**

Reliability definition –Reliability parameters- f(t), F(t) and R(t) functions- Measures of central tendency – Bath tub curve – A priori and posteriori probabilities of failure – Component mortality - Useful life.

UNIT II LIFE DATA ANALYSIS **9**

Data classification – Non parametric methods: Ungrouped, Grouped, Complete, Censored data – Time to failure distributions – Probability plotting: Exponential, Weibull - Goodness of fit tests – Survival graphs.

UNIT III RELIABILITY ESTIMATION **9**

Series parallel configurations – Parallel redundancy – m/n system – Complex systems: RBD approach – Baye's method – Minimal path and cut sets - Fault Tree analysis – Standby system.

UNIT IV RELIABILITY MANAGEMENT **9**

Reliability testing: Failure terminated test – Time terminated test – Upper and lower MTBFs – Sequential Testing – Reliability growth monitoring – Reliability allocation.

UNIT V RELIABILITY IMPROVEMENT **9**

Analysis of downtime – Repair time distribution – Maintainability prediction – Measures of maintainability – Availability definitions – System Availability – Replacement decisions – Economic life.

TOTAL: 45 PERIODS

OUTCOME

- The course enable student the application of reliability in various field of engineering.

REFERENCES

1. An Introduction to Reliability and Maintainability Engineering, Charles E.Ebeling, TMH, 2000.
2. Roy Billington and Ronald N. Allan, Reliability Evaluation of Engineering Systems, Springer, 2007.
3. Reliability Engineering, Srinath L S, East West Publisher, 4th edition.

ML7022 THIN FILM TECHNOLOGY

L	T	P	C
3	0	0	3

OBJECTIVE

- The course is designed to impart the students the knowledge of surface modification technologies of deposition of thin film for different application like optical emission, abrasion resistance, dielectric, electronic applications, energy conversion, etc.

UNIT I BASICS OF THIN FILMS **9**

Cosine law of emission. Emission from a point source. Mass of material condensing on the substrate. Chemical methods: Qualitative study of preparation of thin films by Electroplating, vapour phase growth and anodization. Physical methods: Vacuum evaporation

UNIT II PREPARATION OF THIN FILMS 9

Study of thin film vacuum coating unit - Construction and uses of vapour sources-wire, sublimation, crucible and electron bombardment heated sources. Arc and Laser evaporation. Sputtering - Study of glow Discharge - Physical nature of sputtering - Sputtering yield- Experimental set up for DC sputtering, AC sputtering and RF sputtering. Nucleation and growth of thin films (qualitative study only): Four stages of film growth.

UNIT III DEPOSITION MONITORING AND CONTROL 9

Microbalance, Crystal oscillator thickness monitor, optical monitor, Resistance Monitor. Thickness measurement: Multiple Beam Interferometer, Fizeau (Tolansky) technique - Fringes of equal chromatic order (FECO) method - Ellipsometry (qualitative only).

UNIT IV PROPERTIES OF THIN FILM 9

Sheet resistance - size effect - Electrical conduction in thin metallic films. Effect of Ageing and Annealing - Oxidation - agglomeration. Dielectric properties: DC conduction mechanism - Low field and high field conduction. Breakdown mechanism in dielectric films - AC conduction mechanism. Temperature dependence of conductivity. Optical properties: Optical constants and their determination - Spectrophotometer method. Anti-reflection coatings. Interference filters. Thin film Solar Cells CuInSe2 solar cell.

UNIT V APPLICATION OF THIN FILMS 9

Thin film resistors: Materials and Design of thin film resistors (Choice of resistor and shape and area) - Trimming of thin film resistors - sheet resistance control - Individual resistor trimming. Thin film capacitors: Materials - Capacitor structures - Capacitor yield and capacitor stability. Thin film field effect transistors: Fabrication and characteristics - Thin film diodes.

TOTAL: 45 PERIODS

OUTCOME

- The student will gain knowledge on surface modification technologies of deposition of thin film for different application like optical emission, abrasion resistance, dielectric, electronic applications, energy conversion, etc.

TEXT BOOKS

1. Goswami A, “Thin Film Fundamentals”, New Age International (P) Ltd., 1996.
2. K.L. Chopra, “Thin Film Phenomena”, McGraw-Hill,1983

REFERENCES

1. Rao V V, Ghosh, T.B., Chopra, K.L., “Vacuum Science and Technology”, Allied Publications, 1998
2. Aicha Elshabini-Riadaud Fred D Barlow III, “Thin Film Technology Hand book”, Mc Graw Hill Company, 1997.
3. Maissel L.I and Glang R, “Hand Book of Thin Film Technology”, McGraw Hill, 1970.
4 Anders H, “Thin Films in Optics”, Focal press, 1967.
5. Schwartz B and Schwartz N, “Measurement Techniques for Thin Films”, John Wiley & Sons, 1967.
6. Guthrie A, “Vacuum Technology”, John Wiley and Sons, 1963.

GE7072	FOUNDATION SKILLS IN INTEGRATED PRODUCT DEVELOPMENT	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To understand the global trends and development methodologies of various types of products and services
- To conceptualize, prototype and develop product management plan for a new product based on the type of the new product and development methodology integrating the hardware, software, controls, electronics and mechanical systems
- To understand requirement engineering and know how to collect, analyze and arrive at requirements for new product development and convert them in to design specification
- To understand system modeling for system, sub-system and their interfaces and arrive at the optimum system specification and characteristics
- To develop documentation, test specifications and coordinate with various teams to validate and sustain up to the EoL (End of Life) support activities for engineering customer

UNIT I FUNDAMENTALS OF PRODUCT DEVELOPMENT 9

Global Trends Analysis and Product decision - Social Trends - Technical Trends- Economical Trends - Environmental Trends - Political/Policy Trends **- Introduction to Product Development Methodologies and Management -** Overview of Products and Services - Types of Product Development - Overview of Product Development methodologies **-** Product Life Cycle – Product Development Planning and Management.

UNIT II REQUIREMENTS AND SYSTEM DESIGN 9

Requirement Engineering - Types of Requirements - Requirement Engineering - traceability Matrix and Analysis - Requirement Management - **System Design & Modeling -** Introduction to System Modeling - System Optimization - System Specification - Sub-System Design - Interface Design.

UNIT III DESIGN AND TESTING 9

Conceptualization - Industrial Design and User Interface Design - Introduction to Concept generation Techniques – **Challenges in Integration of Engineering Disciplines** - Concept Screening & Evaluation - **Detailed Design -** Component Design and Verification – **Mechanical, Electronics and Software Subsystems** - High Level Design/Low Level Design of S/W Program **-** Types of Prototypes, S/W Testing- Hardware Schematic, Component design, Layout and Hardware Testing – **Prototyping -** Introduction to Rapid Prototyping and Rapid Manufacturing - **System Integration, Testing, Certification and Documentation**

UNIT IV SUSTENANCE ENGINEERING AND END-OF-LIFE (EOL) SUPPORT 9

Introduction to Product verification processes and stages - Introduction to Product Validation processes and stages - Product Testing Standards and Certification - Product Documentation - **Sustenance -**Maintenance and Repair – Enhancements - **Product EoL -** Obsolescence Management – Configuration Management - EoL Disposal

UNIT V BUSINESS DYNAMICS – ENGINEERING SERVICES INDUSTRY 9

The Industry - Engineering Services Industry - Product Development in Industry versus Academia –**The IPD Essentials -** Introduction to Vertical Specific Product Development processes -Manufacturing/Purchase and Assembly of Systems - Integration of Mechanical, Embedded and Software Systems – Product Development Trade-offs - Intellectual Property Rights and Confidentiality – Security and Configuration Management.

TOTAL: 45 PERIODS

OUTCOMES:

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

- Define, formulate and analyze a problem
- Solve specific problems independently or as part of a team
- Gain knowledge of the Innovation & Product Development process in the Business Context
- Work independently as well as in teams
- Manage a project from start to finish

TEXTBOOKS:

1. Book specially prepared by NASSCOM as per the MoU.
2. Karl T Ulrich and Stephen D Eppinger, "Product Design and Development", Tata McGraw Hill, Fifth Edition, 2011.
3. John W Newstorm and Keith Davis, "Organizational Behavior", Tata McGraw Hill, Eleventh Edition, 2005.

REFERENCES:

1. Hiriyappa B, “Corporate Strategy – Managing the Business”, Author House, 2013.
2. Peter F Drucker, “People and Performance”, Butterworth – Heinemann [Elsevier], Oxford, 2004.
3. Vinod Kumar Garg and Venkita Krishnan N K, “Enterprise Resource Planning – Concepts”, Second Edition, Prentice Hall, 2003.
4. Mark S Sanders and Ernest J McCormick, "Human Factors in Engineering and Design", McGraw Hill Education, Seventh Edition, 2013