NETAJI SUBHAS UNIVERSITY

JAMSHEDPUR, JHARKHAND

Established under the **Jharkhand State Private University Act, 2018**

Approved by AICTE, PCI, BCI, NCTE, INC & JNRC

COURSE STRUCTURE

&

DETAILED SYLLABUS

OF

METALLURGICAL ENGINEERING

FOR

B.TECH. FOUR YEAR DEGREE COURSE

(Applicable for the batches admitted from (2025-2026)

DEPARTMENT OF METALLURGICAL ENGINEEERING

NETAJI SUBHAS UNIVERSITY, JAMSHEDPUR

Pokhari, Near Bhilai Pahadi, Jamshedpur, Jharkhand

India (831012)

PREAMBLE

Metallurgical Engineering is a dynamic and evolving discipline that integrates scientific principles, problem-solving approaches, and practical knowledge to study, design, process, and improve materials-primarily Metals and their alloys—to Meet the growing demands of industry and society. The curriculum revision committee, comprising experts from leading academic institutions, government R&D laboratories, and the manufacturing sector, undertook a comprehensive review during 2021–2022. The committee studied globally benchmarked curricula and engaged with domain specialists across diverse sectors to ensure a well-rounded and future-ready framework.

The revised model curriculum addresses both current and emerging needs of the materials industry and technological landscape. It offers a balanced blend of foundational science, core engineering, advanced technological tools, and experiential learning through laboratories, projects, and industry-driven applications. Recognizing the increasing relevance of electronics, information, and communication technologies in material processing, characterization, and design, the curriculum has strengthened related course offerings.

To support diverse career paths, students are provided enhanced flexibility through a wide range of elective courses. This enables them to shape their education in alignment with aspirations in research, industry, innovation, entrepreneurship, or higher studies. The curriculum is carefully aligned with the New Education Policy, fostering holistic, inter-disciplinary, and hands-on learning. Emphasis has been placed on real-world applications, skill development, and integration of industrial examples and practices to prepare graduates for impactful roles in a rapidly transforming world.

VISION

To strive for excellence in education, research, and entrepreneurship, with the ultimate goal of becoming a global hub for innovation. Committed to advancing scientific and technological services, we aim to contribute Meaningfully to society.

MISSION

- To provide high-quality education that nurtures innovation, entrepreneurship, and ethical values, shaping future professionals equipped for a globally competitive landscape.
- To collaborate with stakeholders by sharing institutional expertise in education and knowledge, fostering mutual growth in technical learning.
- To Cultivate an environment that encourages fresh ideas, groundbreaking research, and academic excellence, paving the way for future leaders, innovators, and entrepreneurs.
- To drive socio-economic progress by offering impactful scientific and technological solutions to society.

PROGRAM EDUCATIONAL OBJECTIVES (PEOS)

PEO-1	Obtain good and high positions in public or private institutions as engineers and researchers.
PEO-2	Follow higher education in prestigious universities and have a successful academic career.
PEO-3	Demonstrate advancement in their chosen career by upgrading their skills continuously.
PEO-4	Exhibit high ethical standards and responsibilities towards their profession and society.

PROGRAM OUTCOMES (POs)

PO1	**Engineering Knowledge:** Knowledge of mathematics, science, and engineering fundamentals and ability to apply them to solve complex Metallurgical phenomena.
PO2	**Problem Analysis:** Identification and analysis of process - structure – property – performance correlation of Metals and materials with the knowledge of science and engineering principles.
PO3	**Design/Development of solutions:** Ability to design material systems, components, process to Meet the desired needs within the realistic constraints of economic, public safety, environmental, manufacturability, and sustainability.

PO4	**Conduct Investigations of Complex problems:** Design, conduct, analyze, and interpret the results of tests and researches in the field of Metallurgical engineering and propose appropriate Measures for efficient capacity utilization of systems; components and equipment etc. with minimum energy and rejects.
PO5	**Modern Tool Usage:** Select and apply appropriate Methods for analysis and characterization of materials to check the quality and performance and usage of modern tools to address the specific needs of Metallurgical industries.
PO6	**The Engineer and Society:** Propose appropriate measures for protection and modifying equipment, systems and processes from damage, degradation and inefficiency due to various physical, chemical and Mechanical environments.
PO7	**Environment and Sustainability:** Understanding the impact of various Metallurgical processes on environment and suggest appropriate measures for viable alternatives and taking measures for reuse, recycle and reclamation ofrejects and byproducts.
PO8	**Ethics:** An understanding of professional and ethical responsibility towards engineering practice and profession.
PO9	**Individual and Team Work:** Ability to function in diverse teams and works.
PO10	**Communication:** Ability to effectively communicate in professional context through oral presentations and written technical reports as well as successfully work in group oriented tasks.
PO11	**Project Management and Finance:** Demonstrate the fundamental knowledge and skills associated with technical and management principles and application of them at individual and as Member or a leader of a team and in multidisciplinary environment at various platforms.
PO12	**Life-Long Learning:** Recognition of the need; ability and awareness to engage independently and exhibit creativity; innovations and proactive demeanor for engaging in lifelong learning.

PROGRAM SPECIFIC OUTCOMES (PSOs)

PSO 1	Apply Metallurgical principles to provide ecological and cost effective solutions for Metalextraction and refining industries and manufacturing industries.
PSO 2	Identify, evaluate and modify existing materials and their behavior with respect to structure – property – processing – performance applications and develop new materials that are sustainable, economical and eco-friendly with tailor made properties and applications.

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6	Semester IV	85	100
7	Semester V	101	117
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9	Semester VII	133	155
10	Semester VIII	156	181

B. TECH IN METALLURGICAL ENGINEERING
COURSE STRUCTURE
GENERAL COURSE STRUCTURE & THEME

A. Definition of Credit:

1 Hr. Lecture (L) per week	1 Credit
1 Hr. Tutorial (T) per week	1 Credit
1 Hr. Practical (P) per week	0.5 Credit
2 Hours Practical (P) per week	1 Credit

B. Range of Credits: In the light of the fact that a typical Model Four-year Under Graduate degree program in Engineering has about 160 credits, the total number of credits proposed for the four-year B. Tech/B.E. in Metallurgical Engineering (Engineering & Technology) is kept as 160.

C. Structure of UG Program in MT: The structure of UG program in Metallurgical Engineering shall have essentially the following categories of courses with the breakup of credits as given:

Sl.	Category	Breakup of Credits (Total 168)
1	Humanities and Social Sciences including Management courses	12
2	Basic Science courses	25
3	Engineering Science courses including workshop, drawing, basics of electrical/Mechanical/computer etc.	21
4	Professional core courses	74
5	Professional Elective courses relevant to chosen specialization/branch	9
6	Open subjects – Electives from other technical and /or emerging subjects	6
7	Employment Enhancement Courses (Project work, seminar and internship in industry or elsewhere.)	21
8	Mandatory Courses [Environmental Sciences, Induction Program, Indian Constitution, Essence of Indian Knowledge Tradition]	(non-credit)
Total		**168**

D. Course code and definition:

Course code	Definitions
L	Lecture
T	Tutorial
P	Practical
C	Credits
BSC	Basic Science Courses
ESC	Engineering Science Courses
HSMC	Humanities and Social Sciences including Management courses
PCC	Professional core courses
PEC	Professional Elective courses
OEC	Open Elective courses
LC	Laboratory course

MC	Mandatory courses
EEC	Employment Enhancement Courses (Project/Summer Internship/Seminar)

Category-wise Courses

HUMANITIES & SOCIAL SCIENCES COURSES [HS] & MANAGEMENT COURSES

(2 compulsory + 2 others)

Number of Humanities & Social Science Courses: 4
Credits: 12

Sl.	Code No.	Subject	Semester	Credits
1	HSMC 01	English for Technical Writing (Compulsory Course)	2	2:0:2=3
2	HSMC 02	Universal Human Values (Compulsory Course)	2	2:1:0=3
3	HSMC 03	Industrial Psychology	5 / 6	3:0:0=3
4	HSMC 04	Production & Operation Management	5 / 6	3:0:0=3
5	HSMC 05	Project Management	5 / 6	3:0:0=3
6	HSMC 06	Finance & Accounting	5 / 6	3:0:0=3
			Total Credits:	**12**

BASIC SCIENCE COURSE [BSC] (Total 6)

Sl.	Code No.	Subject	Semester	Credits
1	BSC 101	Physics-1 (Electromagnetism)	1	3:1:2=5
2	BSC 102	Mathematics-1 (Calculus & Linear Algebra)	1	3:1:0=4
3	BSC 202	Chemistry-1	2	3:0:2=4
4	BSC 201	Mathematics-2 (ODE, Complex variables)	2	3:1:0=4
5	BSC 301	Mathematics-3 (PDE, Prob/Stat)	3	3:1:0=4
6	BSC 604	Environment Science	6	4:0:0=4
			Total Credits:	**25**

ENGINEERING SCIENCE COURSE [ESC] (Total 6)

Sl.	Code No.	Subject	Semester	Credits
1	ESC 103	Basic Electrical Engineering	1	2:1:2=4
2	ESC 104	Engineering Drawing	1	1:0:4=3
3	ESC 106P	Design Thinking + Idea Lab (Audit)	1	0:0:2=1
4	ESC 204	Programming for Problem Solving	2	2:0:4=4
5	ESC 206P	Manufacturing Practice Workshop	2	0:0:4=2
6	ESC 305	Testing of Material	3	3:0:2=4
7	ESC 605	Environmental Science	6	3:0:0=3
			Total Credits:	**21**

PROFESSIONAL CORE COURSES [PCC] (Total 16)

Sl.	Code No.	Subject	Semester	Credits
1	PCC-MT 302	Mineral Processing	3	3:1:2=5
2	PCC- MT 303	Metallurgical Thermodynamics - I	3	3:1:0=4
3	PCC- MT 304	Principle of Extractive Metallurgy	3	3:0:0=3
4	PCC- MT 306	Physical Metallurgy	3	3:0:2=4
5	PCC- MT 401	Transport Phenomena	4	3:1:0=4
6	PCC- MT 402	Metallurgical Thermodynamics - II	4	4:0:0=4
7	PCC- MT 403	Non-ferrous process Metallurgy	4	3:0:0=3
8	PCC- MT 404	Metal Casting	4	3:0:2=4
9	PCC- MT 405	Mechanical Metallurgy	4	3:0:0=3
10	PCC- MT 406	Powder Metallurgy	4	3:1:2=5
11	PCC- MT 502	Light Metals & Alloys	5	3:1:0=4
12	PCC- MT 503	Heat Treatment and Phase Transformations	5	3:1:2=5
13	PCC- MT 504	Metal Forming and Metal Joining	5	3:0:2=4
14	PCC- MT 505	Iron and Steel Making	5	3:1:0=4
15	PCC- MT 601	Ceramics and Composites Materials	6	4:0:0=4
16	PCC- MT 602	Fuels, Furnaces and Refractories	6	4:0:2=5
17	PCC- MT 604	Materials characterization techniques		4:0:2=5
18	PCC- MT 701	Finite Element Analysis		4:0:0=4
			Total Credits:	**74**

PROFESSIONAL ELECTIVE [PEC]
(Total 3 to be taken, at least one from each group)

Sl.	Code No.	Subject	Semester	Credits
		TECHNOLOGY GROUP		
1	PEC	Solidification Processing	7 / 8	3:0:0=3
2	PEC	Non-Metallic Materials	7 / 8	3:0:0=3
3	PEC	Functional Materials	7 / 8	3:0:0=3
4	PEC	Renewable energy engineering	7 / 8	3:0:0=3
5	PEC	Internet of Things	7 / 8	3:0:0=3
6	PEC	Alloy Steel	7 / 8	3:0:0=3
		INDUSTRY SECTOR GROUP		
1	PEC	Bio Materials	7 / 8	3:0:0=3
2	PEC	Electronic Materials	7 / 8	3:0:0=3
3	PEC	High Temperature Materials	7 / 8	3:0:0=3
4	PEC	Gas dynamics and Jet Propulsion	7 / 8	3:0:0=3
5	PEC	Additive Manufacturing	7 / 8	3:0:0=3
6	PEC	Sustainable Development	7 / 8	3:0:0=3
			Total Credits:	**9**

ENGINEERING PROJECT (3 Stages)

Sl.	Code No.	Subject	Semester	Credits
1	PROJ-MT607P	Engineering Project-1 (Literature Review)	6	0:0:4=2
2	PROJ-MT705P	Engineering Project-2 (Design & Analysis)	7	0:0:10=5
3	SEM- MT706	Seminar	7	0:0:2=1
4	PROJ-MT803P	Engineering Project-3 (Prototype & Testing)	8	0:0:16=8
			Total Credits:	**16**

TOTAL = 168 credits | BSC = 18%, ESC = 15%, PCC = 36%, PEL+HSM+OEL = 9%, PROJ = 12% || LABS = 10%

INDUCTION PROGRAM

The Essence and Details of Induction program can also be understood from the 'Detailed Guide on Student Induction program', as available on AICTE Portal, (Link:https://www.aicteindia.org/sites/default/files/Detailed%20Guide%20on%20Student%20Induc tion%20program.pdf).

Induction program (mandatory)	Three-week duration
Induction program for students to be offered right at the start of the first year.	• Physical activity • Creative Arts • Universal Human Values • Literary • Proficiency Modules • Lectures by Eminent People • Visits to local Areas • Familiarization to Dept./Branch & Innovations

Mandatory Visits/ Workshop/Expert Lectures:

a. It is mandatory to arrange one industrial visit every semester for the students of each branch.

b. It is mandatory to conduct a One-week workshop during the winter break after fifth semester on professional/ industry/ entrepreneurial orientation.

c. It is mandatory to organize at least one expert lecture per semester for each branch by inviting resource persons from domain specific industry.

Evaluation Scheme (Suggestive only):

a. **For Theory Courses**:

(The weightage of internal assessment is 40% and for End Semester Exam is 60%)

b. For Practical Courses:

(The weightage of internal assessment is 60% and for End Semester Exam is 40%)

c. For Summer Internship / Projects / Seminar etc.

Evaluation is based on work done, quality of report, performance in viva-voce, presentation etc.

Note: The internal assessment is based on the student's performance in mid semester tests (two best out of three), quizzes, assignments, class performance, attendance, viva-voce in practical, lab record etc.

Mapping of Marks to Grades

Each course (Theory/Practical) is to be assigned 100 marks, irrespective of the number of credits, and the mapping of marks to grades may be done as per the following table:

Range of Marks	Assigned Grade
91-100	A^+
81-90	A
71-80	B^+
61-70	B
51-60	C^+
46-50	C
40-45	D
< 40	F (Fail due to less marks)

B.TECH. IN METALLURGICAL ENGINEERING

COURSE STRUCTURE

1st SEMESTER

Sl.	Code No.	Category	Name of the Subjects	Periods			Credits	Marks		
				L	T	P		IA	TE	TM
1	BTBSC 101	BSC	Engineering Mathematics- I	3	1	0	4	40	60	100
2	BTBSC 102	BSC	Engineering Physics-1	3	1	-	4	40	60	100
3	BTESC 103	ESC	Basics of Electrical Engineering	3	0	-	3	40	60	100
4	BTESC 104	ESC	Engineering Drawing	1	0	-	1	40	60	100
5	BTMC 105	MC	Indian Knowledge System	3	0	-	3	40	60	100
Practical										
6	BTBSC 102P	BSC	Engineering Physics Lab	-	-	2	1	30	20	50
7	BTESC 103P	ESC	Basics of Electrical Engineering Lab	-	-	2	1	30	20	50
8	BTESC 104P	ESC	Engineering Drawing & Computer Graphics Lab	-	-	4	2	30	20	50
9	BTESC 106P	ESC	Design Thinking & IDEA Lab	-	-	2	1	30	20	50
10	BTAU 107	AU	Sports/NSS/NCC/YOGA/Painting/Music/Classical dance		-	2	0	-	-	-
Total				**13**	**2**	**12**	**20**	**320**	**380**	**700**

SEMESTER-II

Sl.	Code No.	Category	Name of the Subjects	Periods			Credits	Marks		
				L	T	P		IA	TE	TM
1	BTBSC 201	BSC	Engineering Mathematics -II	3	1	-	4	40	60	100
2	BTBSC 202	BSC	Engineering Chemistry	3	0	-	3	40	60	100
3	BTHSMC 203	HSMC	English for technical writing	2	0	0	2	40	60	100
4	BTESC 204	ESC	Programming for Problem Solving	2	0	-	2	40	60	100
5	BTHSMC 205	HSMC	Universal Human Values	2	1	0	3	40	60	100
Practical										
6	BTBSC 202P	BSC	Engineering Chemistry Lab	-	-	2	1	30	20	50
7	BTHSMC 203P	HSMC	English for technical writing	0	0	2	1	30	20	50
8	BTESC 204P	ESC	Programming for Problem Solving Lab	-	-	4	2	30	20	50
9	BTESC 206P	ESC	Manufacturing Practices Workshop			4	2	30	20	50
Total				**12**	**2**	**12**	**20**	**320**	**380**	**700**

III- SEMESTER

Code	Category	Name of the Subject	Periods			Credits	Marks		
			L	T	P		IA	TE	TM
BTBSC301	BSC	Mathematics-3 (PDE, Prob/Stat)	3	1	-	4	40	60	100
BTMT302	PCC	Mineral Processing	3	-	-	3	40	60	100
BTMT303	PCC	Metallurgical Thermodynamics - I	3	1	-	4	40	60	100
BTMT304	PCC	Principles of Extractive Metallurgy	3	-	-	3	40	60	100
BTESC305	ESC	Testing of materials	3		-	3	40	60	100
BTMT306	PCC	Physical Metallurgy	3		-	3	40	60	100
		Practical							
BTMT302P	PCC	Mineral Processing Lab	-	-	2	1	30	20	50
BTESC305 P	ESC	Testing of materials Lab			2	1	30	20	50
BTMT306P	PCC	Physical Metallurgy Lab			2	1	30	20	50
		Total	**18**	**1**	**6**	**23**	**330**	**420**	**750**

IV- SEMESTER

Code	Name of the Subject	Periods			Credits	Marks		
		L	T	P		IA	TE	TM
BTMT401	Transport Phenomena	3	1	-	4	40	60	100
BTMT402	Metallurgical Thermodynamics - II	4	-	-	4	40	60	100
BTMT403	Non- Ferrous Process Metallurgy	3	-	-	3	40	60	100
BTMT404	Metal Casting	3	-	-	3	40	60	100
BTMT405	Mechanical Metallurgy	3		-	3	40	60	100
BTMT406	Powder Metallurgy	3	1	-	4	40	60	100
	Practical							
BTMT403P	Non- Ferrous Process Metallurgy Lab	-	-	2	1	30	20	50
BTMT404P	Metal Casting Lab	-	-	2	1	30	20	50
BTMT406P	Powder Metallurgy Lab			2	1	30	20	50
	Total	**19**	**2**	**6**	**24**	**330**	**420**	**750**

V- SEMESTER

Code	Name of the Subject	Periods			Credits	Marks		
		L	T	P		IA	TE	TM
BTMT501	Business Economics & Financial Analysis	3	-	-	3	40	60	100
BTMT502	Light Metals & Alloys	3	1	-	4	40	60	100
BTMT503	Heat Treatment and Phase Transformations	3	1	-	4	40	60	100
BTMT504	Metal Forming and Metal Joining	3	-	-	3	40	60	100
BTMT505	Iron and Steel Making	3	1	-	4	40	60	100
BTEEC506	Employment Enhancement Course-I	-	-	2	1	40	60	100
	Practical							
BTMT503P	Heat Treatment and Phase Transformations Lab	-	-	2	1	30	20	50
BTMT504P	Metal Forming and Metal Joining Lab	-	-	2	1	30	20	50
BTEEC507P	Internship / Summer Industrial Training/ Seminar (4-6 Week)	0	0	4	2	30	20	50
	Total	**15**	**3**	**10**	**23**	**330**	**420**	**750**

VI-SEMESTER

Code	Name of the Subject	Periods			Credits	Marks		
		L	T	P		IA	TE	TM
BTMT601	Ceramics and Composite Materials	4	-	-	4	40	60	100
BTMT602	Fuels, Furnaces and Refractories	4	-	-	4	40	60	100
BTMT603	Production & Operation Management	3	-	-	3	40	60	100
BTMT604	Materials characterization techniques	4	-	-	4	40	60	100
BTESC605	Environmental Science	3	-	-	3	40	60	100
BTEEC606	Employment Enhancement Course-II	-		2	1	40	60	100
	Practical							
BTMT602P	Fuels, Furnaces and Refractories Lab	-	-	2	1	30	20	50
BTMT604P	Materials Characterization Techniques Lab	-	-	2	1	30	20	50
BTEEC607P	Eng. Project – I (Literature Review)	0	0	4	2	30	20	50
	Total	**18**	**0**	**10**	**23**	**330**	**420**	**750**

VII- SEMESTER

Code	Name of the Subject	Periods			Credits	Marks		
		L	T	P		IA	TE	TM
BTMT701	Finite Element Analysis	4	-	-	4	40	60	100
BTMT702	Professional Elective -1	3	1	-	3	40	60	100
BTMT703	Open Elective – I	3	-	-	3	40	60	100
BTMT704	Open Elective – II	3	-	-	3	40	60	100
	Practical							
BTMT702P	Environmental Degradation of Materials lab			2	1	30	20	50
BTMT705P	Eng. Project -2 (Design & Analysis)	0	0	10	5	40	60	100
BTEEC706P	Internship /Summer Industrial Training/ Seminar (4-6 Week)	0	0	4	2	30	20	50
	Total	**13**	**1**	**16**	**21**	**260**	**340**	**600**

VIII- SEMESTER

Code	Name of the Subject	Periods			Credits	Marks		
		L	T	P		IA	TE	TM
BTMT801	Professional Elective -2	3		-	3	40	60	100
BTMT802	Professional Elective -3	3	-	-	3	40	60	100
Practical								
BTEEC803P	Engineering Project-3 (Prototype & Testing)	-	-	16	8	80	120	200
	Total	**6**		**16**	**14**	**160**	**240**	**400**

PROFESSIONAL ELECTIVE COURSES

CATEGORY	TECHNOLOGY GROUP	INDUSTRY SECTOR GROUP	CEDITS
PEC	Solidification Processing	Bio Materials	3
PEC	Non Metallic Materials	Electronic Materials	3
PEC	Functional Materials	High Temperature Materials	3
PEC	Renewable energy engineering	Gas dynamics and Jet Propulsion	3
PEC	Internet of Things	Additive Manufacturing	3
PEC	Alloy Steel	Sustainable Development	3

OPEN ELECTIVE COURSES

Sl.	Category	Name of the Subject	Semester	Credits
1	OEC	Artificial intelligence and Machine learning	7/8	3
2	OEC	Cyber security Laws, Standards & IPR	7/8	3
3	OEC	Project Management	7/8	3
4	OEC	Introduction to Instrumentation	7/8	3
5	OEC	Nuclear Metallurgy	7/8	3
6	OEC	Corrosion Process and Control	7/8	3
7	OEC	Computational materials engineering	7/8	3

HUMANITIES & SOCIAL SCIENCES COURSES [HS] & MANAGEMENT COURSES

Humanities & Social Sciences & Mgt. Electives (HSM): Any 2 courses from the list of those offered.

Sl.	Category	Subject	Semester	Credits
1	HSMC	Communication Skills / English (Compulsory	2	3
2	HSMC	Universal Human Values-2 (Compulsory course)	2	3
3	HSMC	Industrial Psychology	5/6	3
4	HSMC	Operations Research	5/6	3
5	HSMC	Production & Operation Management	5/6	3
6	HSMC	Environmental Science	5/6	3

Employment Enhancement Courses

Sl.	Category	Subject	Semester	Credits
1	EEC	Employment Enhancement Course-I	5	**01**
2	EEC	Employment Enhancement Course-II	6	**01**
3	EEC	Internship / Summer Industrial Training/ Seminar (4-6 Week)	5/7	**04**
4	EEC	Engg. Project – I/II/III	6/7/8	**15**

SEMESTER –I

ENGINEERING MATHEMATICS-I

Subject Code: -	**BTBSC101**	**IA Marks**	**40**
Number of Lecture Hours/Week:-	**04**	**Term End Exam Marks**	**60**
Total Number of Lecture Hours:-	**60**	**CREDITS**	**04**

Course Objectives:

The goal of this course is to achieve conceptual understanding and to retain the best traditions of traditional calculus. The syllabus is designed to provide the basic tools of calculus mainly for the purpose of modelling the engineering problems mathematically and obtaining solutions. This is a foundation course which mainly deals with topics such as single variable and multivariable calculus and plays an important role in the understanding of science, engineering, economics and computer science, among other disciplines.

Assessment Plan:

Criteria	Description	Maximum Marks
Internal Assessment (IA)	Internal Examination	30
	Attendance/Discipline	5
	Assignment/ Seminar	5
Terminal Examination (TE)	Terminal Examination	60
Total		100
Attendance	A minimum of 75% Attendance is required to be maintained by a student to be qualified for taking up the End Semester examination. The allowance of 25% includes all types of leaves including medical leaves.	

Course Contents:

Module 1: Basic Calculus: (12 hours)

Curvature, evolutes and involutes; Evaluation of definite and improper integrals; Beta and Gamma functions and their properties; Applications of definite integrals to evaluate surface areas and volumes of revolutions.

Module 2: Single-variable Calculus (Differentiation): (12 hours)

Rolle's Theorem, Mean value theorems and applications; Extreme values of functions; Linear approximation; Indeterminate forms and L' Hospital's rule.

Module 3: Sequences and series: (12 hours)

Limits of sequence of numbers, Calculation of limits, Infinite series; Tests for convergence; Power series, Taylor and Maclaurin series; Taylor theorem, convergence of Taylor series, error estimates.

Module 4: Multivariable Calculus (Differentiation): (12 hours)

Limit, continuity and partial derivatives, directional derivatives, gradient, total derivative; Tangent plane and normal line; Maxima, minima and saddle points; Method of Lagrange multipliers.

Module 5: Multivariable Calculus (Integration): (12 hours)

Multiple Integration: Double integrals (Cartesian), change of order of integration in double integrals, Change of variables (Cartesian to polar), Applications: areas and volumes, Center of mass and Gravity (constant and variable densities); Triple integrals (Cartesian), orthogonal curvilinear coordinates,

Simple applications involving cubes, sphere and rectangular parallelepipeds; Scalar line integrals, vector line integrals, scalar surface integrals, vector surface integrals, Gradient, curl and divergence, Theorems of Green, Gauss and Stokes.

TEXTBOOKS/REFERENCES:

1. AICTE's Prescribed Textbook: Mathematics-I (Calculus & Linear Algebra) ISBN: 9789391505172
2. Reena Garg, Engineering Mathematics, Khanna Book Publishing Company, 2022.
3. Reena Garg, Advanced Engineering Mathematics, Khanna Book Publishing Company, 2021.
4. G.B. Thomas and R.L. Finney, Calculus and Analytic geometry, 9th Edition, Pearson, Reprint, 2002.
5. Erwin Kreyszig, Advanced Engineering Mathematics, 9th Edition, John Wiley & Sons, 2006.
6. Ramana B.V., Higher Engineering Mathematics, Tata McGraw Hill New Delhi, 11th Reprint, 2010.
7. Veerarajan T., Engineering Mathematics for first year, Tata McGraw-Hill, New Delhi, 2008.
8. N.P. Bali and Manish Goyal, A text book of Engineering Mathematics, Laxmi Publications, Reprint, 2008.
9. B.S. Grewal, Higher Engineering Mathematics, Khanna Publishers, 36th Edition, 2010.

Course outcomes: The objective of this course is to familiarize the prospective engineers with techniques in calculus, multivariate differentiation and integration. It aims to equip the students with standard concepts and tools at an intermediate to advanced level that will serve them well towards tackling more advanced level of mathematics and applications that they would find useful in their disciplines.

At the end of the course, the students will learn

CO1. To apply differential and integral calculus to notions of curvature and to improper integrals. Apart from some other applications they will have a basic understanding of Beta and Gamma functions.

CO2. The fallouts of Rolle's Theorem that is fundamental to application of analysis to Engineering problems.

CO3. The tool of power series and Fourier series for learning advanced Engineering Mathematics.

CO4. To deal with functions of several variables that are essential in most branches of engineering.

CO5. To acquaint the student with mathematical tools needed in evaluating multiple integrals and their usage.

Course Outcome No	Statement	Knowledge Level (KL)
CO1	To apply differential and integral calculus to notions of curvature and to improper integrals. Apart from some other applications they will have a basic understanding of Beta and Gamma functions.	K_1
CO2	The fallouts of Rolle's Theorem that is fundamental to application of analysis to Engineering problems.	K_2
CO3	The tool of power series and Fourier series for learning advanced Engineering Mathematics.	K_3
CO4	To deal with functions of several variables that are essential in most branches of engineering.	K_2
CO5	To acquaint the student with mathematical tools needed in evaluating multiple integrals and their usage.	K_2

KL- Bloom's Knowledge Level (K_1, K_2, K_3, K_4, K_5, K_6)

K_1-Remember, K_2- Understand, K_3- Apply, K_4- Analyze, K_5- Evaluate, K_6- Create

Course Articulation Matrix: (Mapping of COs with POs & PSOs)

CO	CORRELATION WITH PROGRAM OUTCOMES												CORRELATION WITH PSOs	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	1									1				
CO2		2			1									
CO3			2				1				1			
CO4								2				1		
CO5				1									1	
CO(Average)	1	2	2	1	1		1	2			1	1	1	

3 –High; 2 –Medium; 1 –Low

ENGINEERING PHYSICS-I (ELECTROMAGNETISM)

Subject Code:-	**BTBSC102**	**IA Marks**	**40**
Number of Lecture Hours/Week:-	**04**	**Term End Exam Marks**	**60**
Total Number of Lecture Hours:-	**60**	**CREDITS**	**04**

Course Objective:
To enhance the fundamental knowledge in Physics and its applications relevant to various streams of Engineering and Technology.

Assessment Plan:

Criteria	Description	Maximum Marks
Internal Assessment (IA)	Internal Examination	30
	Attendance/Discipline	5
	Assignment/ Seminar	5
Terminal Examination (TE)	Terminal Examination	60
Total		100
Attendance	A minimum of 75% Attendance is required to be maintained by a student to be qualified for taking up the End Semester examination. The allowance of 25% includes all types of leaves including medical leaves.	

Course Contents:

Module 1: Electrostatics in vacuum (15 hours)

Calculation of electric field and electrostatic potential for a charge distribution; Divergence and curl of electrostatic field; Laplace's and Poisson's equations for electrostatic potential and uniqueness of their solution and connection with steady state diffusion and thermal conduction; Practical examples like Faraday's cage and coffee-ring effect; Boundary conditions of electric field and electrostatic potential; method of images; energy of a charge distribution and its expression in terms of electric field.

Module 2: Electrostatics in a linear dielectric medium (10 hours)

Electrostatic field and potential of a dipole. Bound charges due to electric polarization; Electric

displacement; boundary conditions on displacement; Solving simple electrostatics problems in presence of dielectrics – Point charge at the center of a dielectric sphere, charge in front of a dielectric slab, dielectric slab and dielectric sphere in uniform electric field.

Module 3: Magneto statics (10 hours)
Bio-Savart law, Divergence and curl of static magnetic field; vector potential and calculating it for a given magnetic field using Stokes' theorem; the equation for the vector potential and its solution for given current densities.

Module 4: Magneto statics in a linear magnetic medium (10 hours)
Magnetization and associated bound currents; auxiliary magnetic field H; Boundary conditions on B and H. Solving for magnetic field due to simple magnets like a bar magnet; magnetic susceptibility and ferromagnetic, paramagnetic and diamagnetic materials; Qualitative discussion of magnetic field in presence of magnetic materials.

Module 5: Faraday's law (15 hours)
Faraday's law in terms of EMF produced by changing magnetic flux; equivalence of Faraday's law and motional EMF; Lenz's law; Electromagnetic breaking and its applications; Differential form of Faraday's law expressing curl of electric field in terms of time-derivative of magnetic field and calculating electric field due to changing magnetic fields in quasi-static approximation; energy stored in a magnetic field.

Text Books/Suggested References:

1. AICTE's Prescribed Textbook: Physics (Introduction to Electromagnetic Theory) with Lab Manual, ISBN: 978-93-91505-165
2. Bhattacharya & Nag, Engineering Physics
3. David Griffiths, Introduction to Electrodynamics
4. Halliday and Resnick, Physics
5. W. Saslow, Electricity, magnetism and light
6. Malik, Singh, Engineering Physics, Tata McGraw Hill

Alternative NPTEL/SWAYAM Course:

S. No.	NPTEL Course Name	Instructor	Host Institute
1	INTRODUCTION TO ELECTROMAGNETIC THEORY	PROF. MANOJ HARBOLA	IIT KANPUR

Course Outcomes:

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

CO1. Identify and understand the kinds of experimental results which are incompatible with classical Physics leading to the development of a quantum theory of matter and light.
CO2. Use basic concepts to analyse and design a wide range of semiconductor devices.
CO3. Understand & solve different types of wave equations.
CO4. Use the principles of optics to solve various complex engineering problems.
CO5. Use fundamental laws and relations to solve problems in electricity, electromagnetism.

Course Outcome No	Statement	Knowledge Level (KL)
CO1	Identify and understand the kinds of experimental results which are incompatible with classical Physics leading to the development of a quantum theory of matter and light.	K_1
CO2	Use basic concepts to analyse and design a wide range of semiconductor devices.	K_2
CO3	Understand & solve different types of wave equations.	K_3
CO4	Use the principles of optics to solve various complex engineering problems.	K_3
CO5	Use fundamental laws and relations to solve problems in electricity, electromagnetism.	K_4

KL- Bloom's Knowledge Level (K_1, K_2, K_3, K_4, K_5, K_6)

K_1-Remember, K_2- Understand, K_3- Apply, K_4- Analyze, K_5- Evaluate, K_6- Create

Course Articulation Matrix: (Mapping of COs with POs & PSOs)

CO	CORRELATION WITH PROGRAM OUTCOMES												CORRELATION WITH PSOs	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	3										3		
CO2			2		3									1
CO3				2								1		
CO4			3	2										
CO5			3							2				
CO(Average)	2	3	2.6	2	3					2		2		1

3 –High; 2 –Medium; 1 –Low

BASIC ELECTRICAL ENGINEERING

Subject Code: -	**BTESC103**	**IA Marks**	**40**
Number of Lecture Hours/Week:-	**03**	**Term End Exam Marks**	**60**
Total Number of Lecture Hours: -	**45**	**CREDITS**	**03**

Course Objective:

The objective of this Course is to provide the students with an introductory and broad treatment of the field of Electrical Engineering.

Assessment Plan:

Criteria	Description	Maximum Marks
Internal Assessment (IA)	Internal Examination	30
	Attendance/Discipline	5
	Assignment/ Seminar	5
Terminal Examination (TE)	Terminal Examination	60
Total		100
Attendance	A minimum of 75% Attendance is required to be maintained by a student to be qualified for taking up the End Semester examination. The allowance of 25% includes all types of leaves including medical leaves.	

Course Contents:

Module 1: (10 hours)

D. C. Circuits covering, Ohm's Law and Kirchhoff's Laws; Analysis of series, parallel and series-parallel circuits excited by independent voltage sources; Power and energy; Electromagnetism covering, Faradays Laws, Lenz's Law, Fleming's Rules, Statically and dynamically induced EMF; Concepts of self-inductance, mutual inductance and coefficient of coupling; Energy stored in magnetic fields;

Module 2: (10 hours)

Single Phase A.C. Circuits covering, Generation of sinusoidal voltage- definition of average value, root mean square value, form factor and peak factor of sinusoidal voltage and current and phasor representation of alternating quantities; Analysis with phasor diagrams of R, L, C, RL, RC and RLC circuits; Real power, reactive power, apparent power and power factor, series, parallel and series-parallel circuits; Three Phase A.C. Circuits covering, Necessity and Advantages of three phase systems, Generation of three phase power, definition of Phase sequence, balanced supply and balanced load; Relationship between line and phase values of balanced star and delta connections; Power in balanced three phase circuits, measurement of power by two wattmeter method;

Module 3: (5 hours)

Transformers covering, Principle of operation and construction of single-phase transformers (core and shell types). EMF equation, losses, efficiency and voltage regulation; Synchronous Generators covering, Principle of operation; Types and constructional features; EMF equation;

Module 4: (10 hours)

DC Machines covering, working principle of DC machine as a generator and a motor; Types and constructional features; EMF equation of generator, relation between EMF induced and terminal voltage enumerating the brush drop and drop due to armature reaction; DC motor working principle; Back EMF and its significance, torque equation; Types of D.C. motors, characteristics and applications; Necessity of a starter for DC motor;

Module 5: (10 hours)

Three Phase Induction Motors covering; Concept of rotating magnetic field; Principle of operation, types and constructional features; Slip and its significance; Applications of squirrel cage and slip ring motors; Necessity of a starter, star-delta starter.

TEXT/REFERENCS BOOKS:

1. AICTE's Prescribed Textbook: Basic Electrical Engineering (ISBN: 978-93-91505-158)
2. Ritu Sahdev (2022), Basic Electrical Engineering, Khanna Book Publishing.
3. Nagrath I.J. and D. P. Kothari (2001), Basic Electrical Engineering, Tata McGraw Hill.
4. Hayt and Kimberly, Engineering Circuit Analysis, Tata McGraw Hill.
5. Kulshreshtha D.C. (2009), Basic Electrical Engineering, Tata McGraw Hill.
6. Rajendra Prasad (2009), Fundamentals of Electrical Engineering, Prentice Hall, India Hughes, E. 2005)
7. Mittel & Mittal, Basic Electrical Engineering, Tata McGraw Hill.

Alternative NPTEL/SWAYAM Course:

S. No.	NPTEL Course Name	Instructor	Host Institute

1	BASIC ELECTRIC CIRCUITS	PROF. ANKUSH SHARMA	IIT KANPUR
2	BASIC ELECTRICAL CIRCUITS	PROF. NAGENDRA KRISHNAPURA	IITM
3	FUNDAMENTALS OF ELECTRICAL ENGINEERING	PROF. DEBAPRIYA DAS	IIT KGP

COURSE OUTCOMES:

At the end of the course, the students will learn:

CO1. Understand the basic knowledge of electrical quantities such as current, voltage, power, energy and frequency

CO2. Predict the behaviour of any electrical and magnetic circuits.

CO3. Formulate and solve complex AC, DC circuits.

CO4. Identify the type of electrical machine used for that particular application.

CO5. Realize the requirement of transformers in transmission and distribution of electric power and other applications.

Course Outcome No	Statement	Knowledge Level (KL)
CO1	Identify and understand the kinds of experimental results which are incompatible with classical Physics leading to the development of a quantum theory of matter and light.	K_1
CO2	Use basic concepts to analyse and design a wide range of semiconductor devices.	K_2
CO3	Understand & solve different types of wave equations.	K_3
CO4	Use the principles of optics to solve various complex engineering problems.	K_3
CO5	Use fundamental laws and relations to solve problems in electricity, electromagnetism.	K_4

KL- Bloom's Knowledge Level (K_1, K_2, K_3, K_4, K_5, K_6)

K_1-Remember, K_2- Understand, K_3- Apply, K_4- Analyze, K_5- Evaluate, K_6- Create

Course Articulation Matrix: (Mapping of COs with POs)

CO	CORRELATION WITH PROGRAM OUTCOMES												CORRELATION WITH PSOs	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	3										3		
CO2			2		3									1
CO3				2								1		
CO4			3	2										
CO5			3							2				
CO(Average)	2	3	2.6	2	3					2		2		1

3 –High; 2 –Medium; 1 –Low

ENGINEERING DRAWING

Subject Code: -	**BTESC104**	**IA Marks**	**40**
Number of Lecture Hours/Week: -	**03**	**Term End Exam Marks**	**60**
Total Number of Lecture Hours: -	**45**	**CREDITS**	**03**

COURSE OBJECTIVE(S):
The objective of this Course is to provide the basic knowledge about Engineering Drawing. Detailed concepts are given in projections, technical drawing, dimensioning and specifications, so useful for a student in preparing for an engineering career.

Assessment Plan:

Criteria	Description	Maximum Marks
Internal Assessment (IA)	Internal Examination	30
	Attendance/Discipline	5
	Assignment/ Seminar	5
Terminal Examination (TE)	Terminal Examination	60
Total		100
Attendance	A minimum of 75% Attendance is required to be maintained by a student to be qualified for taking up the End Semester examination. The allowance of 25% includes all types of leaves including medical leaves.	

COURSE CONTENTS:
Traditional Engineering Graphics: Principles of Engineering Graphics; Orthographic Projection; Descriptive Geometry; Drawing Principles; Isometric Projection; Surface Development; Perspective; Reading a Drawing; Sectional Views; Dimensioning & Tolerances; True Length, Angle; intersection, Shortest Distance.
Computer Graphics: Engineering Graphics Software; -Spatial Transformations; Orthographic Projections; Model Viewing; Co-ordinate Systems; Multi-view Projection; Exploded Assembly; Model Viewing; Animation; Spatial Manipulation; Surface Modelling; Solid Modelling; Introduction to Building Information Modelling (BIM).
(Except the basic essential concepts, most of the teaching part can happen concurrently in the laboratory)
Module 1: Introduction to Engineering Drawing (10 hours)
Principles of Engineering Graphics and their significance, usage of Drawing instruments, lettering, Conic sections including the Rectangular Hyperbola (General method only); Cycloid, Epicycloid, Hypocycloid and Involute; Scales – Plain, Diagonal and Vernier Scales;

Module 2: Orthographic Projections (10 hours)
Principles of Orthographic Projections-Conventions - Projections of Points and lines inclined to both planes; Projections of planes inclined Planes - Auxiliary Planes;

Module 3: Projections of Regular Solids (5 hours)
Covering those inclined to both the Planes- Auxiliary Views; Draw simple annotation, dimensioning and scale. Floor plans that include: windows, doors, and fixtures such as WC, bath, sink, shower, etc.

Module 4: Sections and Sectional Views of Right Angular Solids (10 hours)
Prism, Cylinder, Pyramid, Cone – Auxiliary Views; Development of surfaces of Right Regular Solids - Prism, Pyramid, Cylinder and Cone; Draw the sectional orthographic views of geometrical solids,

objects from industry and dwellings (foundation to slab only).

Module 5: Isometric Projections (10 hours)
Principles of Isometric projection – Isometric Scale, Isometric Views, Conventions; Isometric Views of lines, Planes, Simple and compound Solids; Conversion of Isometric Views to Orthographic Views and Vice-versa, Conventions;

Text/Reference Books:

1. AICTE's Prescribed Textbook: Engineering Graphics & Design (ISBN: 978-93-91505-066)
2. Jain, Maheshwari, Gautam (2021), Engineering Graphics & Design, Khanna Book Publishing.
3. Bhatt N.D., Panchal V.M. & Ingle P.R., (2014), Engineering Drawing, Charotar Publishing.
4. Shah, M.B. & Rana B.C. (2008), Engineering Drawing and Computer Graphics, Pearson.
5. Agrawal B. & Agrawal C. M. (2012), Engineering Graphics, TMH Publication.
6. Narayana, K.L. & P Kannaiah (2008), Text book on Engineering Drawing, Scitech Publishers.
7. (Corresponding set of) CAD Software Theory and User Manuals.

Alternative NPTEL/SWAYAM Course:

S. No.	NPTEL Course Name	Instructor	Host Institute
1	PROF. RAJARAM LAKKARAJU	IIT KHARAGPUR	Engineering Drawing and Computer Graphics
2	PROF. NIHAR RANJAN PATRA	IIT KANPUR	Engineering Graphics

Course Outcomes:
All phases of manufacturing or construction require the conversion of new ideas and design concepts into the basic line language of graphics. Therefore, there are many areas (civil, mechanical, electrical, architectural and industrial) in which the skills of the CAD technicians play major roles in the design and development of new products or construction. Students prepare for actual work situations through practical training in a new state-of-the-art computer designed CAD laboratory using engineering software. This course is designed to address:

At the end of the course, the students will learn:

CO1. To describe engineering design and its place in society.
CO2. To discuss the visual aspects of engineering design.
CO3. To use engineering graphics standards.
CO4. To illustrate solid modelling.
CO5. To use computer-aided geometric design.
CO6. To design creating working drawings.
CO7. To inspect engineering communication.

Course Outcome No	Statement	Knowledge Level (KL)
CO1	To describe engineering design and its place in society.	K_1
CO2	To discuss the visual aspects of engineering design.	K_2

CO3	To use engineering graphics standards.	K_3
CO4	To illustrate solid modelling.	K_2
CO5	To use computer-aided geometric design.	K_3
CO6	To design creating, working, drawings.	K_6
CO7	To inspect engineering communication.	K_5

KL- Bloom's Knowledge Level (K_1, K_2, K_3, K_4, K_5, K_6)

K_1-Remember, K_2- Understand, K_3- Apply, K_4- Analyze, K_5- Evaluate, K_6- Create

Course Articulation Matrix: (Mapping of COs with POs)

CO	CORRELATION WITH PROGRAM OUTCOMES												CORRELATION WITH PSOs	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1			3											
CO2				3					2					
CO3		2												
CO4						3								
CO5														
CO6		2							2			1	1	1
CO7	2													
CO(Average)	2	2	3	3		3			2			1	1	1

3 –High; 2 –Medium; 1 –Low

Indian Knowledge System

Subject Code: -	**BTMC105**	**IA Marks**	**40**
Number of Lecture Hours/Week: -	**03**	**Term End Exam Marks**	**60**
Total Number of Lecture Hours: -	**45**	**CREDITS**	**03**

Course Objective

The course aims at imparting basic principles of thought process, reasoning and differencing. Sustainability is at the core of Indian Traditional knowledge Systems connecting society and nature. Holistic life style of yogic science and wisdom capsules in Sanskrit literature are also important in modern society with rapid technological advancements and societal disruptions. Part-I focuses on introduction to Indian Knowledge Systems, Indian perspective of modern scientific world-view, and basic principles of Yoga and holistic health care system.

Assessment Plan:

Criteria	Description	Maximum Marks
Internal Assessment (IA)	Internal Examination	30
	Attendance/Discipline	5
	Assignment/ Seminar	5
Terminal Examination (TE)	Terminal Examination	60
Total		100

Attendance	A minimum of 75% Attendance is required to be maintained by a student to be qualified for taking up the End Semester examination. The allowance of 25% includes all types of leaves including medical leaves.

Course Content: -

Module -1 (10 Hours)

Basics of Ancient Indian Knowledge and Diverse Fields from Health (Yoga), Agriculture, Performing Arts etc.

Yoga - Patanjali and Panini, Yoga Sutras & Mahabhashya, Yoga from Ancient Rishis, Munies, Sages and Seers, Different types of Yogas, Asanas & Pranayamas, Vagbhata Samhita for Health Benefits.

Agriculture - Ancient Agricultural Trends, Practices & means of Transportation in Agriculture.

Performing Arts – Different types of Ancient Arts, i.e; Murtikala, Embossing in Jewellery, Different School of Arts in Ancient India : Mathura, Gandhara and Amravati School, Pottery & Utensil making from Mud.

Module -2 (10 Hours)

Ancient Indian Knowledge in Various Science Streams like Physics, Chemistry, Biology, Forestry, Mathematics etc.

Gravitational Laws, Concept of Pendulum, Ancient knowledge of Space & Astronomy related to Outer Space and different Celestial Bodies, i.e; Planetary System, Stars and their Movement.

Chemistry – Ancient Knowledge of Rasayanas, Preservative Methods using Oil and Salt etc.

Biology & Forestry – Rich Cultural Heritage of Ayurveda, Different types of Medicinal uses of Plants, Fauna, Flora. Study of Animal and Plant Fossils, Interaction/ Inter-relation of Mankind and Nature on Mutually Beneficial Basis. Traditional methods for conservation of Forests, Trees and Preventing Soil Erosion.

Mathematics – Present Day Decimal System traces its History to Ancient India, Giving the concept of Zero as a number to the World, Negative Numbers, basic Arithmetic and Algebraic concept, Knowledge of Advance Trigonometry in Ancient India.

Module -3 (8 Hours)

Ancient Indian Knowledge in Civil Engineering, Metallurgy, Mechanical Sciences, Textile Technology etc

Civil Engineering Concept and Familiarity with Sthapaty Kala, the Art of Construction in Ancient India, Civil Engineering Knowledge in Architecture in Making a Well Planned City by the Harappan Civilization Remains Undisputed. World Heritage Sites of Ajanta, Ellora, Khajuraho, Sanchi, Mahabalipuram are the Testaments of Excellent Civil Engineering Craftsmanship and Architecture, Well Developed Architecture During Cholas, Pal Dynasty is Evident in Various Ancient Temples in Present India. Concept of Canals and Wells for Irrigation & Human Needs in Ancient India is Well Documented

Metallurgy – Concept Well Mentioned in Vedic Age Texts Using the Term Ayas for Metals, Minting/ Metal Casting Of Gold, Silver, Bronze, Copper for Utensils and Jewellery During Ancient India.

Module -4 (7 Hours)

Mechanical Sciences – Agriculture and Military Equipments like Hammer, Tongs, Idea of Basic Mechanical Concept for Transportation Using Bullock-Carts, Handpulled Carts Using Wheels, Chariots, Boats Using Patwar (Rudder) During Vedic Age ss Well Known, Use of Ploughing Tools Made of Metals and Wood etc.

Textile Technology – Archaeological Evidence of Cotton Textile at Mohenjo Daro in the Indus

Valley, Use of Charkhas and Traditional Yarns like Khadi, Silk Fabric from Silk Worm and export of quality Silk to West and European Countries is well established.

Module -5 (10 Hours)

Ancient Indian Knowledge in Electrical, Electronics, Computational Studies, Instrumentation etc. Ancient India Knowledge in Generation of Electricity from Water, Silk and Clouds, Agastya Samhita Speaks about Electroplating, Basic knowledge of Computations and Instrumentation during Vedic Period, Musical Instruments like Seven-Holed Flute and other Stringed Instruments like Ravanahatha, Cymbals, Dhol (Drum) found by Archaeologists from Indus Valley Civilization Sites.

Course Outcomes:

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

CO1. Basic principles of thought process, reasoning and differencing.

CO2. Introduction to Indian Knowledge Systems, Indian perspective of modern scientific world-view and basic principles of Yoga and holistic health care systems.

CO3. Focuses on Indian philosophical traditions, Indian linguistic tradition and Indian artistic tradition.

TEXT BOOKS

1. Sivaramakrishnan (Ed.), Cultural Heritage of India-course material, Bhartiya.
2. Vidya Bhavan, Mumbai. 5th Edition, 2014 Swami Jitatmanand, Modern Physics and Vedant, Bharatiya Vidya Bhavan
3. Swami Jitatmanand, Holistic Science and Vedant, BharatiyaVidyaBhavan.
4. Meena Rao (2006), Fundamental concepts in Law of Contract, 3rd Edn. Professional Offset
5. Fritzof Capra, The Wave of life.

REFERENCE BOOKS

1. VN Jha (Eng. Trans.), Tarkasangraha of Annam Bhatta, International Chinmay
2. Foundation, Velliarnad, Arnakulam Yoga Sutra of Patanjali, Ramakrishna Mission, Kolkata R3. GN Jha (Eng. Trans.), Ed. RN Jha, Yoga-darshanam with Vyasa Bhashya
3. VidyanidhiPrakashan, Delhi 2016 RNJha, Science of Consciousness Psychotherapyand Yoga Practices, Vidyanidhi
4. Prakashan, Delhi 2016 P B Sharma (English translation), ShodashangHridayan

Course Outcome No	Statement	Knowledge Level (KL)
CO1	Basic principles of thought process, reasoning and differencing.	K_1
CO2	Introduction to Indian Knowledge Systems, Indian perspective of modern scientific world-view and basic principles of Yoga and holistic health care systems.	K_2
CO3	Focuses on Indian philosophical traditions, Indian linguistic tradition and Indian artistic tradition.	K_3

KL- Bloom's Knowledge Level (K_1, K_2, K_3, K_4, K_5, K_6)

K_1-Remember, K_2- Understand, K_3- Apply, K_4- Analyze, K_5- Evaluate, K_6- Create

Course Articulation Matrix: (Mapping of COs with POs & PSOs)

CO	CORRELATION WITH PROGRAM OUTCOMES												CORRELATION WITH PSOs	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1			3											
CO2				3					2					
CO3		2												
CO(Average)	2	2	3	3		3			2			1	1	1

3 –High; 2 –Medium; 1 –Low

ENGINEERING PHYSICS LAB

Subject Code: - BTBSC102P	**IA Marks 30**
Number of Lecture Hours/Week: - 02	**Term End Exam Marks 20**
Total Number of Lecture Hours: - 15	**CREDITS 01**

Course Objective

- To study the use of physical principles and analysis in various fields of engineering and technology.
- To supplement the theoretical knowledge gained in the lecture by hands-on experience with the equipment. This will develop scientific temper and help to apply the basic concepts and principles in solving engineering problems.
- Demonstrate an ability to make physical measurements & understand the limits of precision measurement.

Course Outcomes:

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

CO1. Understand calculation of specific resistance of wire by Carey Foster bridge

CO2. Calculate thermal conductivity of poor conductors

CO3. Measure resonance frequency and quality factor of LCR Circuit & RC circuit with AC current

CO4. Study the characteristics of transistors, photoelectric cells and determine operational parameters associated with their performance.

CO5. Work with laboratory sodium light and lasers. Understand method to measure the wavelength of the light emitted from a laser and Sodium light.

Assessment Plan:

Criteria	Description	Maximum Marks
Internal Assessment (IA)	Internal Examination	20
	Attendance/Discipline	5
	Assignment/ Seminar	5
Terminal Examination (TE)	Terminal Examination	20
Total		50
Attendance	A minimum of 75% Attendance is required to be maintained by a student to be qualified for taking up the End Semester examination. The allowance of 25% includes all types of leaves including medical leaves.	

SYLLABUS

Sl. No.	Name of Experiments
1.	To determine the specific resistance of the material of a wire by Carey Foster bridge
2.	To determine the Planck‟s constant using LED.
3.	To determine the wavelength of sodium light by using Newton‟s ring apparatus.
4.	To find the wave length of sodium light using Fresnel‟s biprism
5.	To determine dispersive power of the material of the prism with the help of a Spectrometer
6.	To determine the number of lines per centimeter of the plane diffraction grating by using sodium light.
7.	To determine the thermal conductivity of following bad conductor (a) ebonite (b) mica sheet (c) wooden By Lee‟s disc method
8.	To determine the co-efficient of viscosity of glycerin by Stoke‟s method.
9.	To determine acceleration due to gravity by a Bar Pendulum.
10.	To determine input & output characteristics of a PNP Junction Transistor in CE and CB configuration.
11.	To determine input & output characteristics of a NPN Junction Transistor in CE and CB configuration
12.	To study resonance phenomena in LCR circuits with AC current
13.	To measure moment of inertia of Flywheel
14.	To determine the Lorentz force in a vacuum tube.
15.	To measure the numerical aperture of an optical fiber.
16.	To obtain the particle size by Laser
17.	To obtain forbidden energy gap of Semiconductor Diode.
18.	To obtain Dielectric constant.
19.	To obtain Curie temperature
20.	To determine the time constant of an RC circuit.

Text Book:

1. A Text Book of Engineering Physics Practical by Dr. Ruby Das, C.S. Robinson, Dr. Rajesh Kumar & Prashant Kumar Sahu; Pub University Science Press.
2. Fundamentals of Physics extended volume by Resnick, Halliday and Walker; Pub.:John Wiley & Sons. Inc. Asian Edition.

Reference Books:

1. Advanced level Physics Practical, Michael Nelson and Jon M. Ogborn, Heinemann Educational Publishers.
2. Engineering Practical Physics, S. Panigrahi & B. Mallick,2015, Cengage Learning India Pvt. Ltd.

Course Outcome No	Statement	Knowledge Level (KL)
CO1	Understand calculation of specific resistance of wire by Carey Foster bridge	K_1
CO2	Calculate thermal conductivity of poor conductors	K_2
CO3	Measure resonance frequency and quality factor of LCR Circuit & RC circuit with AC current	K_3
CO4	Study the characteristics of transistors, photoelectric cells and determine operational parameters associated with their performance.	K_2
CO5	Work with laboratory sodium light and lasers. Understand method to measure the wavelength of the light emitted from a laser and Sodium light.	K_3

KL- Bloom's Knowledge Level (K_1, K_2, K_3, K_4, K_5, K_6)

K_1-Remember, K_2- Understand, K_3- Apply, K_4- Analyze, K_5- Evaluate, K_6- Create

Course Articulation Matrix: (Mapping of COs with Pos & PSOs)

CO	CORRELATION WITH PROGRAM OUTCOMES												CORRELATION WITH PSOs	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	3										3		
CO2			2		3									1
CO3				2								1		
CO4			3	2										
CO5			3							2				
CO(Average)	2	3	2.6	2	3					2		2		1

3 –High; 2 –Medium; 1 –Low

BASICS OF ELECTRICAL ENGINEERING LAB

Subject Code: -	**BTESC103P**	**IA Marks**	**30**
Number of Lecture Hours/Week: -	**02**	**Term End Exam Marks**	**20**
Total Number of Lecture Hours: -	**15**	**CREDITS**	**01**

Course Objective

- To impart a basic knowledge of electrical instruments voltmeter, ammeter, multi-meter, and oscilloscope. Real-life resistors, capacitors and inductors. Measurement such as current, voltage, power, energy and frequency to understand the impact of technology in a global and societal context.
- Emphasize the effects of electric shock and precautionary measures.
- Improve the ability to function on multi-disciplinary team.

Course Outcomes:

At the end of the course, students will be able

CO1. Study different meters and instruments for measurement of electrical quantities
CO2. Study the linear and nonlinear characteristics of different types of loads experimentally.
CO3. Design and experiment potential divider circuits
CO4. Experimentally verify the basic circuit theorems.
CO5. Measure power and power factor in ac circuits.

Assessment Plan:

Criteria	Description	Maximum Marks
Internal Assessment (IA)	Internal Examination	20
	Attendance/Discipline	5
	Assignment/ Seminar	5
Terminal Examination (TE)	Terminal Examination	20
Total		50
Attendance	A minimum of 75% Attendance is required to be maintained by a student to be qualified for taking up the End Semester examination. The allowance of 25% includes all types of leaves including medical leaves.	

Course Outcome No	Statement	Knowledge Level (KL)
CO1	Study different meters and instruments for measurement of electrical quantities	K_1
CO2	Study the linear and nonlinear characteristics of different types of loads experimentally.	K_2
CO3	Design and experiment potential divider circuits	K_3
CO4	Experimentally verify the basic circuit theorems.	K_2
CO5	Measure power and power factor in ac circuits.	K_3

KL- Bloom's Knowledge Level (K_1, K_2, K_3, K_4, K_5, K_6)

K_1-Remember, K_2- Understand, K_3- Apply, K_4- Analyze, K_5- Evaluate, K_6- Create

Course Articulation Matrix: (Mapping of COs with POs & PSOs)

CO	CORRELATION WITH PROGRAM OUTCOMES												CORRELATION WITH PSOs	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3													
CO2		1	2											
CO3				3									1	1
CO4														
CO5														
CO(Average)	3	1	2	3									1	1

3 –High; 2 –Medium; 1 –Low

ENGINEERING DRAWING & COMPUTER GRAPHICS LAB

Subject Code: - BTESC104P	**IA Marks 30**
Number of Lecture Hours/Week: - 04	**Term End Exam Marks 20**
Total Number of Lecture Hours: - 30	**CREDITS 02**

Course Objective

- Increase ability to communicate with people
- Learn to sketch and take field dimensions.
- Learn to take data and transform it into graphic drawings.
- Learn basic Auto Cad skills.
- Learn basic engineering drawing formats
- Prepare the student for future Engineering positions

Course Outcomes:

At the end of the course, students will be able

CO1. Perform basic sketching techniques
CO2. Understanding of architectural and engineering scales will increase.
CO3. Able to draw orthographic projections and sections.
CO4. Ability to produce engineered drawings will improve.
CO5. Become familiar with office practice and standards.

Assessment Plan:

Criteria	Description	Maximum Marks
Internal Assessment (IA)	Internal Examination	20
	Attendance/Discipline	5
	Assignment/ Seminar	5
Terminal Examination (TE)	Terminal Examination	20
Total		50
Attendance	A minimum of 75% Attendance is required to be maintained by a student to be qualified for taking up the End Semester examination. The allowance of 25% includes all types of leaves including medical leaves.	

Course Content

GENERAL INTRODUCTION: Significance of engineering drawing, Introduction to CAD, Lettering, Dimensioning, Scales, Sense of proportioning, Conic sections – General methods only, Different types of projections,

ORTHOGRAPHIC PROJECTIONS OF POINTS AND LINES: Orthographic projections, Projections of points, Projections of lines in different quadrants, traces, inclinations, and true lengths of the line's projections on auxiliary planes. shortest distance, intersecting and non- intersecting lines.

PROJECTIONS OF PLANE FIGURES: Different cases of plane figures (of different shapes) making different angles with one or both reference planes and lines lying in the plane figures making different given angles (with one or both reference planes). Obtaining true shape of the plane figure by projection.

PROJECTION OF SOLIDS &SECTION OF SOLID: Simple cases when solid are placed in different positions Axis faces and tines lying in the faces of the solid making given angles. Sectional orthographic views of geometrical solids.

DEVELOPMENT OF SURFACE & ISOMETRIC PROJECTION: Development of simple objects with and without sectioning, Concept of Isometric Projection.

TEXT BOOKS

1. Engineering Graphics, N.D Bhatt, Charotar Publishing House Pvt. Limited
2. Principle of Engineering Graphics and Drawing, R.K Dhawan, S. Chand Publishing
3. Engineering Graphics and Drafting, P.S GILL, S. K. Kataria& Sons

REFERENCE BOOKS

1. Engineering Drawing and Computer Graphics, Shah, M.B. & Rana B.C. Pearson Education
2. Engineering Graphics, Agrawal B. & Agrawal C. M, TMH Publication
3. Text book on Engineering Drawing, Narayana, K.L. & P Kannaiah, Scitech Publishers

Course Outcome No	Statement	Knowledge Level (KL)
CO1	Perform basic sketching techniques.	K_1
CO2	Understanding of architectural and engineering scales will increase.	K_2
CO3	Able to draw orthographic projections and sections.	K_3
CO4	Ability to produce engineered drawings will improve.	K_2
CO5	Become familiar with office practice and standards.	K_3

KL- Bloom's Knowledge Level (K_1, K_2, K_3, K_4, K_5, K_6)

K_1-Remember, K_2- Understand, K_3- Apply, K_4- Analyze, K_5- Evaluate, K_6- Create

Course Articulation Matrix: (Mapping of COs with POs & PSOs)

CO	CORRELATION WITH PROGRAM OUTCOMES												CORRELATION WITH PSOs	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3		2										
CO2	1													
CO3													2	
CO4					1				2					
CO5														
CO(Average)	2	3		2	1				2				2	

3 –High; 2 –Medium; 1 –Low

DESIGN THINKING & IDEA LAB

Subject Code: -	**BTESC106P**	**IA Marks**	**30**
Number of Lecture Hours/Week: -	**02**	**Term End Exam Marks**	**20**
Total Number of Lecture Hours: -	**15**	**CREDITS**	**01**

COURSE OBJECTIVE(S):
The objective of this Course is to provide the new ways of creative thinking and learn the innovation cycle of Design Thinking process for developing innovative products which useful for a student in preparing for an engineering career.

COURSE CONTENTS:

Module 1: An Insight to Learning Understanding the Learning Process, Kolb's Learning Styles, Assessing and Interpreting

Module 2: Basics of Design Thinking
Definition of Design Thinking, Need for Design Thinking, Objective of Design Thinking, Concepts & Brainstorming, Stages of Design Thinking Process (explain with examples) – Empathize, Define, Ideate, Prototype, Test

Module 3: Prototyping & Testing
What is Prototype? Why Prototype? Rapid Prototype Development process, Testing, Sample Example, Test Group Marketing

Module 4: Design Thinking & Customer Centricity
Practical Examples of Customer Challenges, Use of Design Thinking to Enhance Customer Experience, Parameters of Product experience, Alignment of Customer Expectations with Product Design

Module 5: Feedback, Re-Design & Re-Create
Feedback loop, Focus on User Experience, Address "ergonomic challenges, User focused design, rapid prototyping & testing, final product, Final Presentation – "Solving Practical Engineering Problem through Innovative Product Design & Creative Solution".

Course Outcomes (CO):
Student will able to:

- **CO1.** Compare and classify the various learning styles and memory techniques and apply them in their engineering education.
- **CO2.** Analyse emotional experience and inspect emotional expressions to better understand users while designing innovative products.
- **CO3.** Develop new ways of creative thinking and learn the innovation cycle of Design Thinking process for developing innovative products.
- **CO4.** Propose real-time innovative engineering product designs and choose appropriate frameworks, strategies, techniques during prototype development.
- **CO5.** Perceive individual differences and its impact on everyday decisions and further Create a better customer experience.

Text/Reference Books:

1. E Balaguruswamy (2022), Developing Thinking Skills (The way to Success), Khanna Book Publishing Company.

IDEA Lab Workshop

Course Objectives:

CO1. To learn all the skills associated with the tools and inventory associated with the IDEA Lab.
CO2. Learn useful mechanical and electronic fabrication processes.
CO3. Learn necessary skills to build useful and standalone system/ project with enclosures.
CO4. Learn necessary skills to create print and electronic documentation for the system/project

Course Contents:

Unit	Topics	
1.	Electronic component familiarization, Understanding electronic system design flow. Schematic design and PCB layout and Gerber creation using EagleCAD. Documentation using Doxygen, Google Docs, Overleaf. Version control tools - GIT and GitHub. Basic 2D and 3D designing using CAD tools such as FreeCAD, Sketchup, Prusa Slicer, FlatCAM, Inkspace, OpenBSP and VeriCUT.	Introduction to basic hand tools - Tape measure, combination square, Vernier caliper, hammers, fasteners, wrenches, pliers, saws, tube cutter, chisels, vice and clamps, tapping and threading. Adhesives Introduction to Power tools: Power saws, band saw, jigsaw, angle grinder, belt sander, bench grinder, rotary tools. Various types of drill bits,
2.	Familiarization and use of basic measurement instruments - DSO including various triggering modes, DSO probes, DMM, LCR bridge, Signal and function generator. Logic analyzer and MSO. Bench power supply (with 4-wire output) Circuit prototyping using (a) breadboard, (b) Zero PCB (c) 'Manhattan' style and (d) custom PCB. Single, double and multilayer PCBs. Single and double-sided PCB prototype fabrication in the lab. Soldering using soldering iron/station. Soldering using a temperature controlled reflow oven. Automated circuit assembly and soldering using pick and place machines.	Mechanical cutting processes - 3-axis CNC routing, basic turning, milling, drilling and grinding operations, Laser cutting, Laser engraving etc. Basic welding and brazing and other joining techniques for assembly. Concept of Lab aboard a Box.

3.	Electronic circuit building blocks including common sensors. Arduino and Raspberry Pi programming and use. Digital Input and output. Measuring time and events. PWM. Serial communication. Analog input. Interrupts programming. Power Supply design (Linear and Switching types), Wireless power supply, USB PD, Solar panels, Battery types and charging	3D printing and prototyping technology – 3D printing using FDM, SLS and SLA. Basics of 3D scanning, point cloud data generation for reverse engineering. Prototyping using subtractive cutting processes. 2D and 3D Structures for prototype building using Laser cutter and CNC routers. Basics of IPR and patents; Accessing and utilizing patent information in IDEA Lab
4.	Discussion and implementation of a mini project.	
5.	Documentation of the mini project (Report and video).	

Laboratory Activities:

S. No.	List of Lab activities and experiments
1.	Schematic and PCB layout design of a suitable circuit, fabrication and testing of the circuit.
2.	Machining of 3D geometry on soft material such as soft wood or modelling wax.
3.	3D scanning of computer mouse geometry surface. 3D printing of scanned geometry using FDM or SLA printer.
4.	2D profile cutting of press fit box/casing in acrylic (3- or 6-mm thickness)/cardboard, MDF (2 mm) board using laser cutter & engraver.
5.	2D profile cutting on plywood /MDF (6-12 mm) for press fit designs.
6.	Familiarity and use of welding equipment.
7.	Familiarity and use of normal and wood lathe.
8.	Embedded programming using Arduino and/or Raspberry Pi.
9.	Design and implementation of a capstone project involving embedded hardware, software and machined or 3D printed enclosure.

Reference Books:

1. AICTE's Prescribed Textbook: Workshop / Manufacturing Practices (with Lab Manual), ISBN: 978-9391505332
2. All-in-One Electronics Simplified, A.K. Maini; 2021. ISBN-13: 978-9386173393, Khanna Book Publishing Company, New Delhi.

3. Simplified Q&A - Data Science with Artificial Intelligence, Machine Learning and Deep Learning, Rajiv Chopra, ISBN: 978-9355380821, Khanna Book Publishing Company, New Delhi.
4. 3D Printing & Design, Dr. Sabrie Soloman, ISBN: 978-9386173768, Khanna Book Publishing Company, New Delhi.
5. The Big Book of Maker Skills: Tools & Techniques for Building Great Tech Projects. Chris Hackett. Weldon Owen; 2018. ISBN-13: 978-1681884325.
6. The Total Inventors Manual (Popular Science): Transform Your Idea into a Top-Selling Product. Sean Michael Ragan (Author). Weldon Owen; 2017. ISBN-13: 978- 1681881584.
7. Make: Tools: How They Work and How to Use Them. Platt, Charles. Shroff/Maker Media. 2018. ISBN-13: 978-9352137374
8. The Art of Electronics. 3rd edition. Paul Horowitz and Winfield Hill. Cambridge University Press. ISBN: 9780521809269
9. Practical Electronics for Inventors. 4th edition. Paul Sherz and Simon Monk. McGraw Hill. ISBN-13: 978-1259587542
10. Encyclopedia of Electronic Components (Volume 1, 2 and 3). Charles Platt. Shroff Publishers. ISBN-13: 978-9352131945, 978-9352131952, 978-9352133703
11. Building Scientific Apparatus. 4th edition. John H. Moore, Christopher C. Davis, Michael Coplan and Sandra C. Greer. Cambridge University Press. ISBN-13: 978-0521878586
12. Programming Arduino: Getting Started with Sketches. 2nd edition. Simon Monk. McGraw Hill. ISBN-13: 978-1259641633
13. Make Your Own PCBs with EAGLE: From Schematic Designs to Finished Boards. Simon Monk and Duncan Amos. McGraw Hill Education. ISBN-13: 978-1260019193.
14. Pro GIT. 2nd edition. Scott Chacon and Ben Straub. A press. ISBN-13: 978-1484200773
15. Venuvinod, PK., MA. W., Rapid Prototyping – Laser Based and Other Technologies, Kluwer, 2004.
16. Ian Gibson, David W Rosen, Brent Stucker., "Additive Manufacturing Technologies: Rapid Prototyping to Direct Digital Manufacturing", Springer, 2010
17. Chapman W.A.J, "Workshop Technology", Volume I, II, III, CBS Publishers and distributors, 5th Edition,2002.

Course Outcome No	Statement	Knowledge Level (KL)
CO1	Compare and classify the various learning styles and memory techniques and apply them in their engineering education.	K_1
CO2	Analyse emotional experience and inspect emotional expressions to better understand users while designing innovative products.	K_3
CO3	Develop new ways of creative thinking and learn the innovation cycle of Design Thinking process for developing innovative products.	K_4
CO4	Propose real-time innovative engineering product designs and choose appropriate frameworks, strategies, techniques during prototype development.	K_4
CO5	Perceive individual differences and its impact on everyday decisions and further Create a better customer experience.	K_3

KL- Bloom's Knowledge Level (K_1, K_2, K_3, K_4, K_5, K_6)
K_1-Remember, K_2- Understand, K_3- Apply, K_4- Analyze, K_5- Evaluate, K_6- Create

Course Articulation Matrix: (Mapping of COs with POs & PSOs)

CO	CORRELATION WITH PROGRAM OUTCOMES												CORRELATION WITH PSOs	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3													
CO2			2					2						1
CO3														
CO4	1		1							1		1		1
CO5														
CO(Average)	2		1.5					2		1		1		1

3 –High; 2 –Medium; 1 –Low

SPORTS AND YOGA

Subject Code: - BTAU107	**IA Marks 00**
Number of Lecture Hours/Week: - 02	**Term End Exam Marks 00**
Total Number of Lecture Hours: - 15	**CREDITS 00**

Course Objective(s):

- To make the students understand the importance of sound health and fitness principles as they relate to better health.
- To expose the students to a variety of physical and yogic activities aimed at stimulating their continued inquiry about Yoga, physical education, health and fitness.
- To create a safe, progressive, methodical and efficient activity-based plan to enhance improvement and minimize risk of injury.
- To develop among students an appreciation of physical activity as a lifetime pursuit and a means to better health.

Course Contents:

Module 1: Introduction to Physical Education

- Meaning & definition of Physical Education
- Aims & Objectives of Physical Education
- Changing trends in Physical Education

Module 2: Olympic Movement

- Ancient & Modern Olympics (Summer & Winter)
- Olympic Symbols, Ideals, Objectives & Values
- Awards and Honours in the field of Sports in India (Dronacharya Award, Arjuna Award, Dhayanchand Award, Rajiv Gandhi Khel Ratna Award etc.)

Module 3: Physical Fitness, Wellness & Lifestyle

- Meaning & Importance of Physical Fitness & Wellness
- Components of Physical fitness
- Components of Health related fitness
- Components of wellness
- Preventing Health Threats through Lifestyle Change
- Concept of Positive Lifestyle

Module 4: Fundamentals of Anatomy & Physiology in Physical Education, Sports and Yoga

- Define Anatomy, Physiology & Its Importance
- Effect of exercise on the functioning of Various Body Systems. (Circulatory System, Respiratory System, Neuro-Muscular System etc.)

Module 5: Kinesiology, Biomechanics & Sports

- Meaning & Importance of Kinesiology & Biomechanics in Physical Edu. & Sports
- Newton's Law of Motion & its application in sports.
- Friction and its effects in Sports.

Module 6: Postures

- Meaning and Concept of Postures.
- Causes of Bad Posture.
- Advantages & disadvantages of weight training.
- Concept & advantages of Correct Posture.
- Common Postural Deformities – Knock Knee; Flat Foot; Round Shoulders; Lordosis, Kyphosis, Bow Legs and Scoliosis.
- Corrective Measures for Postural Deformities

Module 7: Yoga

- Meaning & Importance of Yoga
- Elements of Yoga
- Introduction - Asanas, Pranayama, Meditation & Yogic Kriyas
- Yoga for concentration & related Asanas (Sukhasana; Tadasana; Padmasana & Shashankasana)
- Relaxation Techniques for improving concentration - Yog-nidra

Module 8: Yoga & Lifestyle

- Asanas as preventive measures.
- Hypertension: Tadasana, Vajrasana, Pavan Muktasana, Ardha Chakrasana, Bhujangasana, Sharasana.
- Obesity: Procedure, Benefits & contraindications for Vajrasana, Hastasana, Trikonasana, Ardh Matsyendrasana.
- Back Pain: Tadasana, Ardh Matsyendrasana, Vakrasana, Shalabhasana, Bhujangasana.
- Diabetes: Procedure, Benefits & contraindications for Bhujangasana, Paschimottasana, Pavan Muktasana, Ardh Matsyendrasana.
- Asthema: Procedure, Benefits & contraindications for Sukhasana, Chakrasana, Gomukhasana, Parvatasana, Bhujangasana, Paschimottasana, Matsyasana.

Module 9: Training and Planning in Sports

- Meaning of Training
- Warming up and limbering down
- Skill, Technique & Style
- Meaning and Objectives of Planning.
- Tournament – Knock-Out, League/Round Robin & Combination.

Module 10: Psychology & Sports

- Definition & Importance of Psychology in Physical Edu. & Sports

- Define & Differentiate Between Growth & Development
- Adolescent Problems & Their Management
- Emotion: Concept, Type & Controlling of emotions
- Meaning, Concept & Types of Aggressions in Sports.
- Psychological benefits of exercise.
- Anxiety & Fear and its effects on Sports Performance.
- Motivation, its type & techniques.
- Understanding Stress & Coping Strategies.

Module 11: Doping

- Meaning and Concept of Doping
- Prohibited Substances & Methods
- Side Effects of Prohibited Substances

Module 12: Sports Medicine

- First Aid – Definition, Aims & Objectives.
- Sports injuries: Classification, Causes & Prevention.
- Management of Injuries: Soft Tissue Injuries and Bone & Joint Injuries

Module 13: Sports / Games

Following subtopics related to any one Game/Sport of choice of student out of:
Athletics, Badminton, Basketball, Chess, Cricket, Kabaddi, Lawn Tennis, Swimming, Table Tennis, Volleyball, Yoga etc.

- History of the Game/Sport.
- Latest General Rules of the Game/Sport.
- Specifications of Play Fields and Related Sports Equipment.
- Important Tournaments and Venues.
- Sports Personalities.
- Proper Sports Gear and its Importance.

Text Books/References:

1. Modern Trends and Physical Education by Prof. Ajmer Singh.
2. Light On Yoga by B.K.S. Iyengar.
3. Health and Physical Education – NCERT (11th and 12th Classes)

Course Outcomes:

On successful completion of the course the students will be able:

1. To practice Physical activities and Hatha Yoga focusing on yoga for strength, flexibility, and relaxation.
2. To learn techniques for increasing concentration and decreasing anxiety which leads to stronger academic performance.
3. To learn breathing exercises and healthy fitness activities
4. To understand basic skills associated with yoga and physical activities including strength and flexibility, balance and coordination.
5. To perform yoga movements in various combination and forms.
6. To assess current personal fitness levels.

Course Outcome No	Statement	Knowledge Level (KL)
CO1	To practice Physical activities and Hatha Yoga focusing on yoga for strength, flexibility, and relaxation.	K_1
CO2	To learn techniques for increasing concentration and decreasing anxiety which leads to stronger academic performance.	K_3
CO3	To learn breathing exercises and healthy fitness activities	K_4
CO4	To understand basic skills associated with yoga and physical activities including strength and flexibility, balance and coordination.	K_4
CO5	To perform yoga movements in various combination and forms.	K_3
CO6	To assess current personal fitness levels.	K_4

KL- Bloom's Knowledge Level (K_1, K_2, K_3, K_4, K_5, K_6)

K_1-Remember, K_2- Understand, K_3- Apply, K_4- Analyze, K_5- Evaluate, K_6- Create

Course Articulation Matrix: (Mapping of COs with POs & PSOs)

CO	CORRELATION WITH PROGRAM OUTCOMES												CORRELATION WITH PSOs	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3													
CO2		1	2											
CO3				3									1	1
CO4														
CO5														
CO6										1				
CO(Average)	3	1	2	3						1			1	1

3 –High; 2 –Medium; 1 –Low

SEMESTER-II

ENGINEERING MATHEMATICS- II

Subject Code: -	**BTBSC201**	**IA Marks**	**40**
Number of Lecture Hours/Week:-	**04**	**Term End Exam Marks**	**60**
Total Number of Lecture Hours: -	**60**	**CREDITS**	**04**

Course Objective:

Mathematics fundamental necessary to formulate, solve and analyse engineering problems.

Assessment Plan:

Criteria	Description	Maximum Marks
Internal Assessment (IA)	Internal Examination	30
	Attendance/Discipline	5
	Assignment/ Seminar	5
Terminal Examination (TE)	Terminal Examination	60
Total		100
Attendance	A minimum of 75% Attendance is required to be maintained by a student to be qualified for taking up the End Semester examination. The allowance of 25% includes all types of leaves including medical leaves.	

Course Content:

Module 1: Matrices (10 hours)

Linear Systems of Equations; Linear Independence; Rank of a Matrix; Determinant, Inverse of a matrix, rank-nullity theorem; System of linear equations; Symmetric, skew-symmetric and orthogonal matrices; Determinants; Eigenvalues and eigenvectors; Orthogonal transformation; Diagonalization of matrices; Cayley-Hamilton Theorem.

Module 2: First order ordinary differential equations: (10 hours)

Exact, linear and Bernoulli's equations. Equations not of first degree: equations solvable for p, equations solvable for y, equations solvable for x and Clairaut's type.

Module 3: Ordinary differential equations of higher orders: (10 hours)

Second order linear differential equations with variable coefficients: Euler-Cauchy equations, solution by variation of parameters; Power series solutions: Legendre's equations and Legendre polynomials, Frobenius method, Bessel's equation and Bessel's functions of the first kind and their properties.

Module 4: Complex Variable – Differentiation: (15 hours):

Differentiation, Cauchy-Riemann equations, analytic functions, harmonic functions, finding harmonic conjugate; elementary analytic functions (exponential, trigonometric, logarithm) and their properties; Conformal mappings, Mobius transformations and their properties.

Module 5: Complex Variable – Integration: (15 hours):

Contour integrals, Cauchy-Goursat theorem (without proof), Cauchy Integral formula (without proof), Liouville's theorem and Maximum-Modulus theorem (without proof); Taylor's series, zeros of analytic functions, singularities, Laurent's series; Residues, Cauchy Residue theorem (without proof),

Evaluation of definite integral involving sine and cosine, Evaluation of certain improper integrals using the Bromwich contour.

TEXTBOOKS/REFERENCES:

1. AICTE's Prescribed Textbook: Mathematics-II (Calculus, Ordinary Differential Equations and Complex Variable) ISBN: 978-93-91505-28-8
2. Reena Garg, Engineering Mathematics, Khanna Book Publishing Company, 2022.
3. Reena Garg, Advanced Engineering Mathematics, Khanna Book Publishing Company, 2021.
4. Erwin Kreyszig, Advanced Engineering Mathematics, 10th Edition, John Wiley & Sons, 2006.
5. Veerarajan T., Engineering Mathematics for first year, Tata McGraw-Hill, New Delhi, 2008.
6. W. E. Boyce and R. C. DiPrima, Elementary Differential Equations and Boundary Value Problems, 9th Edition, Wiley India, 2009.
7. D. Poole, Linear Algebra: A Modern Introduction, 2nd Edition, Brooks/Cole, 2005.
8. S. L. Ross, Differential Equations, 3rd Edition, Wiley India, 1984.
9. E. A. Coddington, An Introduction to Ordinary Differential Equations, Prentice Hall India, 1995.
10. E. L. Ince, Ordinary Differential Equations, Dover Publications, 1958.
11. J. W. Brown and R. V. Churchill, Complex Variables and Applications, 7th Ed., Mc-Graw Hill, 2004.
12. N.P. Bali and Manish Goyal, A text book of Engineering Mathematics, Laxmi Publications, Reprint, 2008.
13. B.S. Grewal, Higher Engineering Mathematics, Khanna Publishers, 36th Edition, 2010.

Note: The modules have been prepared keeping the following from the Textbooks/References in mind:

(1) Module 1: Sections 7.3-7.5, 7.7, 7.8, 8.1-8.4 of [1].
(2) Module 2: Sections 1.4, 1.5 of [1]; Section 5.1 of [2].
(3) Module 3: Sections 2.5, 2.6, 2.10, 5.1, 5.3, 5.4, 5.5 of [1].
(4) Module 4: Sections 13.3 – 13.7, 17.1 – 17.3 of [1].
(5) Module 5: Sections 14.1 – 14.4, 15.2 – 15.4, 16.1 – 16.4 of [1].

COURSE OUTCOMES: The objective of this course is to familiarize the prospective engineers with techniques in matrices, ordinary differential equations and complex variables. It aims to equip the students to deal with advanced level of mathematics and applications that would be essential for their disciplines.

The students will learn:

CO1. The essential tool of matrices and linear algebra in a comprehensive manner.
CO2. The effective mathematical tools for the solutions of differential equations that model physical processes.
CO3. The tools of differentiation and integration of functions of a complex variable that are used in various techniques dealing engineering problems.

Course Outcome No	Statement	Knowledge Level (KL)
CO1	The essential tool of matrices and linear algebra in a comprehensive manner.	K_1
CO2	The effective mathematical tools for the solutions of differential equations that model physical processes.	K_2
CO3	The tools of differentiation and integration of functions of a complex variable that are used in various techniques dealing engineering problems.	K_3

KL- Bloom's Knowledge Level (K_1, K_2, K_3, K_4, K_5, K_6)

K_1-Remember, K_2- Understand, K_3- Apply, K_4- Analyze, K_5- Evaluate, K_6- Create

Course Articulation Matrix: (Mapping of COs with POs & PSOs)

CO	CORRELATION WITH PROGRAM OUTCOMES												CORRELATION WITH PSOs	
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO1	PSO2
CO1	3						1		1					
CO2		1	2											
CO3				3									1	
CO(Average)	3	1	2	3			1		1				1	

3 –High; 2 –Medium; 1 –Low

ENGINEERING CHEMISTRY

Subject Code: -	**BTBSC202**	**IA Marks**	**40**
Number of Lecture Hours/Week:-	**03**	**Term End Exam Marks**	**60**
Total Number of Lecture Hours: -	**45**	**CREDITS**	**03**

Course Objective:

The objective of the Chemistry-I is to acquaint the students with the basic phenomenon/concepts of chemistry, the student faces during course of their study in the industry and Engineering field. The student with the knowledge of the basic chemistry, will understand and explain scientifically the various chemistry related problems in the industry/engineering field. The student will able to understand the new developments and breakthroughs efficiently in engineering and technology. The introduction of the latest (R&D oriented) topics will make the engineering student upgraded with the new technologies.

Assessment Plan:

Criteria	Description	Maximum Marks
Internal Assessment (IA)	Internal Examination	30
	Attendance/Discipline	5
	Assignment/ Seminar	5
Terminal Examination (TE)	Terminal Examination	60
Total		100
Attendance	A minimum of 75% Attendance is required to be maintained by a student to be qualified for taking up the End Semester examination. The allowance of 25% includes all types of leaves including medical leaves.	

Course Content:

Module 1: Atomic and Molecular Structure (10 hours):

Schrodinger equation. Particle in a box solution and their applications for conjugated molecules and nanoparticles. Forms of the hydrogen atom wave functions and the plots of these functions to explore their spatial variations. Molecular orbitals of diatomic molecules and plots of the multicentre orbitals. Equations for atomic and molecular orbitals. Energy level diagrams of diatomic. Pi-molecular orbitals of butadiene and benzene and aromaticity. Crystal field theory and the energy level diagrams for transition metal ions and their magnetic properties. Band structure of solids and the role of doping on band structures.

Module 2: Spectroscopic techniques and applications (8 hours):

Principles of spectroscopy and selection rules. Electronic spectroscopy. Fluorescence and its applications in medicine. Vibrational and rotational spectroscopy of diatomic molecules. Applications. Nuclear magnetic resonance and magnetic resonance imaging, surface characterization techniques. Diffraction and scattering.

Module 3: Intermolecular forces and potential energy surfaces (7 hours):

Ionic, dipolar and van Der Waals interactions. Equations of state of real gases and critical phenomena. Potential energy surfaces of H_3, H2F and HCN and trajectories on these surfaces.

Module 4: Use of free energy in chemical equilibria (10 hours):

Thermodynamic functions: energy, entropy and free energy. Estimations of entropy and free energies. Free energy and EMF. Cell potentials, the Nernst equation and applications. Acid base, oxidation reduction and solubility equilibria. Water chemistry. Corrosion. Use of free energy considerations in metallurgy through Ellingham diagrams.

Module 5: Periodic properties (10 hours):

Effective nuclear charge, penetration of orbitals, variations of s, p, d and f orbital energies of atoms in the periodic table, electronic configurations, atomic and ionic sizes, ionization energies, electron affinity and electronegativity, polarizability, oxidation states, coordination numbers and geometries, hard soft acids and bases, molecular geometries.

Text/Reference Books:

1. AICTE's Prescribed Textbook: Chemistry – I with Lab Manual (ISBN: 978-93-91505-141)
2. Engineering Chemistry, by Manisha Agrawal.
3. University chemistry, by B. H. Mahan.
4. Chemistry: Principles and Applications, by M. J. Sienko and R. A. Plane.
5. Fundamentals of Molecular Spectroscopy, by C. N. Banwell.
6. Engineering Chemistry (NPTEL Web-book), by B. L. Tembe, Kamaluddin and M. S. Krishnan.
7. Physical Chemistry, by P. W. Atkins.
8. A Textbook of Engineering Chemistry, Shashi Chawla.
9. Organic Chemistry: Structure and Function by K. P. C. Volhardt and N. E. Schore, 5th Edition http://bcs.whfreeman.com/vollhardtschore5e/default.asp

EXPERIMENTS THAT MAY BE PERFORMED THROUGH VIRTUAL LABS:

S. No.	Experiment Name	Experiment Link(s)
1	Determination of surface tension and viscosity.	http://pcv-au.vlabs.ac.in/physical-chemistry/Determination_of_Viscosity_of_Organic_Solvents/
2	Ion exchange column for removal of hardness of water.	http://icv-au.vlabs.ac.in/inorganic-chemistry/Water_Analysis_Determination_of_Chemical_Parameters/
3	Determination of chloride content of water.	http://vlabs.iitb.ac.in/vlabs-dev/labs/nitk_labs/Environmental_Engineering_1/experiments/determination-of-chloride-nitk/simulation.html
4	Colligative properties using freezing point depression.	http://pcv-au.vlabs.ac.in/physical-chemistry/Cryoscopy/
5	Determination of the rate constant of a reaction.	http://pcv-au.vlabs.ac.in/physical-chemistry/EMF_Measurement/
6	Determination of cell constant and conductance of solutions.	http://icv-au.vlabs.ac.in/inorganic-chemistry/Water_Analysis_Determination_of_Physical_Parameters/
7	Potentiometry - determination of redox potentials and EMFs.	http://pcv-au.vlabs.ac.in/physical-chemistry/EMF_Measurement/

8	Saponification/acid value of an oil.	http://biotech01.vlabs.ac.in/bio-chemistry/Estimation_of_Saponification_Value_of_Fats_or_Oils/

Course Outcomes: The concepts developed in this course will aid in quantification of several concepts in chemistry that have been introduced at the 10+2 levels in schools. Technology is being increasingly based on the electronic, atomic and molecular level modifications. Quantum theory is more than 100 years old and to understand phenomena at nanometer levels, one has to base the description of all chemical processes at molecular levels. The course will enable the students:

CO1. To analyse microscopic chemistry in terms of atomic and molecular orbitals and intermolecular forces.
CO2. To rationalise bulk properties and processes using thermodynamic considerations.
CO3. To distinguish the ranges of the electromagnetic spectrum used for exciting different molecular energy levels in various spectroscopic techniques
CO4. To rationalise periodic properties such as ionization potential, electronegativity, oxidation states and electronegativity.
CO5. To list major chemical reactions that are used in the synthesis of molecules.

Course Outcome No	Statement	Knowledge Level (KL)
CO1	To analyse microscopic chemistry in terms of atomic and molecular orbitals and intermolecular forces.	K_1
CO2	To rationalise bulk properties and processes using thermodynamic considerations.	K_2
CO3	To distinguish the ranges of the electromagnetic spectrum used for exciting different molecular energy levels in various spectroscopic techniques	K_3
CO4	To rationalise periodic properties such as ionization potential, electronegativity, oxidation states and electronegativity.	K_3
CO5	To list major chemical reactions that are used in the synthesis of molecules.	K_4

KL- Bloom's Knowledge Level (K_1, K_2, K_3, K_4, K_5, K_6)

K_1-Remember, K_2- Understand, K_3- Apply, K_4- Analyze, K_5- Evaluate, K_6- Create

Course Articulation Matrix: (Mapping of COs with POs & PSOs)

CO	CORRELATION WITH PROGRAM OUTCOMES												CORRELATION WITH PSOs	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3						1		1					
CO2	2	1	2											
CO3				3									1	
CO4							2							
CO5	1													
CO(Average)	2	1	2	3			1.5		1				1	

3 –High; 2 –Medium; 1 –Low

ENGLISH FOR TECHNICAL WRITING

Subject Code: -	**BTHSMC203**	**IA Marks**	**40**
Number of Lecture Hours/Week:-	**02**	**Term End Exam Marks**	**60**
Total Number of Lecture Hours: -	**30**	**CREDITS**	**02**

Course Objective:

1. To provide learning environment to practice listening, speaking, reading and writing skills.
2. To assist the students to carry on the tasks and activities through guided instructions and materials.
3. To effectively integrate English language learning with employability skills and training.
4. To provide hands-on experience through case-studies, mini-projects, group and individual presentations.

Assessment Plan:

Criteria	Description	Maximum Marks
Internal Assessment (IA)	Internal Examination	30
	Attendance/Discipline	5
	Assignment/ Seminar	5
Terminal Examination (TE)	Terminal Examination	60
Total		100
Attendance	A minimum of 75% Attendance is required to be maintained by a student to be qualified for taking up the End Semester examination. The allowance of 25% includes all types of leaves including medical leaves.	

Course Content:

Module 1: Vocabulary Building

1.1. The concept of Word Formation
1.2. Root words from foreign languages and their use in English
1.3. Acquaintance with prefixes and suffixes from foreign languages in English to form derivatives.
1.4. Synonyms, antonyms, and standard abbreviations.

Module 2: Basic Writing Skills

1.1. Sentence Structures
1.2. Use of phrases and clauses in sentences
1.3. Importance of proper punctuation
1.4. Creating coherence
1.5. Organizing principles of paragraphs in documents
1.6. Techniques for writing precisely

Module 3: Identifying Common Errors in Writing

1.1. Subject-verb agreement
1.2. Noun-pronoun agreement

1.3. Misplaced modifiers
1.4. Articles
1.5. Prepositions
1.6. Redundancies
1.7. Clichés

Module 4: Nature and Style of sensible Writing

1.1. Describing
1.2. Defining
1.3. Classifying
1.4. Providing examples or evidence
1.5. Writing introduction and conclusion
1.6. Comprehension
1.7. Précis Writing
1.8. Essay Writing

Module 5: Oral Communication

(This Module involves interactive practice sessions in Language Lab)

- Listening Comprehension
- Pronunciation, Intonation, Stress and Rhythm
- Common Everyday Situations: Conversations and Dialogues
- Communication at Workplace
- Interviews
- Formal Presentations

Text/Reference Books:

1. AICTE's Prescribed Textbook: English (with Lab Manual), Khanna Book Publishing Co.
2. Effective Communication Skills. Kul Bhushan Kumar, Khanna Book Publishing, 2022.
3. Practical English Usage. Michael Swan. OUP. 1995.
4. Remedial English Grammar. F.T. Wood. Macmillan.2007
5. On Writing Well. William Zinsser. Harper Resource Book. 2001
6. Study Writing. Liz Hamp-Lyons and Ben Heasly. Cambridge University Press. 2006.
7. Communication Skills. Sanjay Kumar and PushpLata. Oxford University Press. 2011.
8. Exercises in Spoken English. Parts. I-III. CIEFL, Hyderabad. Oxford University Press.

Alternative NPTEL/SWAYAM Course:

S. No.	NPTEL Course Name	Instructor	Host Institute
1	English language for competitive exams	Prof. Aysha iqbal	IIT MADRAS
2.	Technical English for engineers	Prof. Aysha iqbal	IITM

Course Outcomes:

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

CO1. Remembering the basic of the comm Represent unication process and to know the practical implementations in the work place.

CO2. Understanding verbal and non-verbal modes of communication effectively in practical situations

CO3. Analyzing vocalics and basic grammar.

CO4. Creating competence in reading and writing.
CO5. Evaluation of speaking process.

Course Outcome No	Statement	Knowledge Level (KL)
CO1	Remembering the basic of the comm Represent unication process and to know the practical implementations in the work place.	K_1
CO2	Understanding verbal and non-verbal modes of communication effectively in practical situations	K_2
CO3	Analyzing vocalics and basic grammar.	K_3
CO4	Creating competence in reading and writing.	K_6
CO5	Evaluation of speaking process.	K_5

KL- Bloom's Knowledge Level (K_1, K_2, K_3, K_4, K_5, K_6)

K_1-Remember, K_2- Understand, K_3- Apply, K_4- Analyze, K_5- Evaluate, K_6- Create

Course Articulation Matrix: (Mapping of COs with POs & PSOs)

CO	CORRELATION WITH PROGRAM OUTCOMES												CORRELATION WITH PSOs	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3						1		1					
CO2		1	2											
CO3	1			2									1	
CO4					2									
CO5														
CO(Average)	2	1	2	3	2		1		1				1	

3 –High; 2 –Medium; 1 –Low

PROGRAMMING FOR PROBLEM SOLVING

Subject Code: -	**BTESC204**	**IA Marks**	**40**
Number of Lecture Hours/ Week: -	**02**	**Term End Exam Marks**	**60**
Total Number of Lecture Hours: -	**30**	**CREDITS**	**02**

Course Objectives:

1. To learn the fundamentals of computers.
2. To understand the various steps in program development.
3. To learn the syntax and semantics of C programming language.
4. To learn the usage of structured programming approach in solving problems.
5. To understated and formulate algorithm for programming script
6. To analyse the output based on the given input variables.

Assessment Plan:

Criteria	Description	Maximum Marks
Internal Assessment (IA)	Internal Examination	30
	Attendance/Discipline	5
	Assignment/ Seminar	5

Terminal Examination (TE)	Terminal Examination	60
Total		100
Attendance	A minimum of 75% Attendance is required to be maintained by a student to be qualified for taking up the End Semester examination. The allowance of 25% includes all types of leaves including medical leaves.	

Course Contents:

Module 1: (8 hours)

Introduction to Programming; Introduction to components of a computer system (disks, memory, processor, where a program is stored and executed, operating system, compilers etc.) Idea of Algorithm: steps to solve logical and numerical problems. Representation of Algorithm: Flowchart/Pseudocode with examples. From algorithms to programs; source code, variables (with data types) variables and memory locations, Syntax and Logical Errors in compilation, object and executable code.

Module 2: (7 hours)

Arithmetic expressions and precedence. Conditional Branching and Loops. Writing and evaluation of conditionals and consequent branching. Iteration and loops. Arrays, Arrays (1-D, 2-D), Character arrays and Strings. Basic Algorithms, Searching, Basic Sorting Algorithms (Bubble, Insertion and Selection), Finding roots of equations, notion of order of complexity through example programs (no formal definition required)

Module 3: **(8 hours)**

Function, Functions (including using built in libraries), Parameter passing in functions, call by value, Passing arrays to functions: idea of call by reference. Recursion, Recursion as a different way of solving problems. Example programs, such as Finding Factorial, Fibonacci series, Ackerman function etc. Quick sort or Merge sort.

Module 4: (7 hours)

Structures, Defining structures and Array of Structures. Pointers, Idea of pointers, Defining pointers, Use of Pointers in self-referential structures, notion of linked list (no implementation).

Module 5: (5 hours)

File handling (only if time is available, otherwise should be done as part of the lab).

TEXT/REFERENCE BOOKS:

1. AICTE's Prescribed Textbook: Programming for Problem Solving (ISBN: 978-93-91505-219)
2. Byron Gottfried, Schaum's Outline of Programming with C, McGraw-Hill.
3. E. Balaguruswamy, Programming in ANSI C, Tata McGraw-Hill.
4. Brian W. Kernighan and Dennis M. Ritchie, The C Programming Language, Prentice Hall of India.

Alternative NPTEL/SWAYAM Course:

S. No.	NPTEL Course Name	Instructor	Host Institute
1	Introduction to programming in c	Prof. Satyadev nandakumar	IIT KANPUR
2	Problem solving through programming in c	Prof. Anupam basu	IIT KHARAGPUR

COURSE OUTCOMES:

The student will learn following through lectures:

CO1. To formulate simple algorithms for arithmetic and logical problems.
CO2. To translate the algorithms to programs (in C language).
CO3. To test and execute the programs and correct syntax and logical errors.
CO4. To implement conditional branching, iteration and recursion.
CO5. To decompose a problem into functions and synthesize a complete program using divide and conquer approach.
CO6. To use arrays, pointers and structures to formulate algorithms and programs.
CO7. To apply programming to solve matrix addition and multiplication problems and searching and sorting problems.
CO8. To apply programming to solve simple numerical method problems, namely rot finding of function, differentiation of function and simple integration.

Course Outcome No	Statement	Knowledge Level (KL)
CO1	To formulate simple algorithms for arithmetic and logical problems.	K_1
CO2	To translate the algorithms to programs (in C language).	K_2
CO3	To test and execute the programs and correct syntax and logical errors.	K_3
CO4	To implement conditional branching, iteration and recursion.	K_4
CO5	To decompose a problem into functions and synthesize a complete program using divide and conquer approach.	K_1
CO6	To use arrays, pointers and structures to formulate algorithms and programs.	K_3
CO7	To apply programming to solve matrix addition and multiplication problems and searching and sorting problems.	K_3
CO8	To apply programming to solve simple numerical method problems, namely rot finding of function, differentiation of function and simple integration.	K_3

KL- Bloom's Knowledge Level (K_1, K_2, K_3, K_4, K_5, K_6)

K_1-Remember, K_2- Understand, K_3- Apply, K_4- Analyze, K_5- Evaluate, K_6- Create

Course Articulation Matrix: (Mapping of COs with POs & PSOs)

CO	CORRELATION WITH PROGRAM OUTCOMES												CORRELATION WITH PSOs	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3						1		1					
CO2		1	2											
CO3	1			2									1	
CO4					2					2				
CO5											2			
CO6	3													
CO7	1		2				1							
CO8														
CO(Average)	2	1	2	2	2		1		1				1	

3 –High; 2 –Medium; 1 –Low

UNIVERSAL HUMAN VALUES

Subject Code: -	**BTHSMC205**	**IA Marks**	**40**
Number of Lecture Hours/ Week: -	**03**	**Term End Exam Marks**	**60**
Total Number of Lecture Hours: -	**45**	**CREDITS**	**03**

Course Objectives

This introductory course input is intended:

1. To help the students appreciate the essential complementarily between 'VALUES' and 'SKILLS' to ensure sustained happiness and prosperity which are the core aspirations of all human beings.
2. To facilitate the development of a Holistic perspective among students towards life and profession as well as towards happiness and prosperity based on a correct understanding of the Human reality and the rest of existence. Such a holistic perspective forms the basis of Universal Human Values and movement towards value-based living in a natural way.
3. To highlight plausible implications of such a Holistic understanding in terms of ethical human conduct, trustful and mutually fulfilling human behavior and mutually enriching interaction with Nature.

Assessment Plan:

Criteria	Description	Maximum Marks
Internal Assessment (IA)	Internal Examination	30
	Attendance/Discipline	5
	Assignment/ Seminar	5
Terminal Examination (TE)	Terminal Examination	60
Total		100
Attendance	A minimum of 75% Attendance is required to be maintained by a student to be qualified for taking up the End Semester examination. The allowance of 25% includes all types of leaves including medical leaves.	

Course Content

Module 1 – Introduction to Value Education

Lecture 1: Right Understanding, Relationship and Physical Facility (Holistic Development and the Role of Education)
Lecture 2: Understanding Value Education
Tutorial 1: Practice Session -Sharing about Oneself
Lecture 3: Self-exploration as the Process for Value Education
Lecture 4: Continuous Happiness and Prosperity – the Basic Human Aspirations
Tutorial 2: Practice Session-Exploring Human Consciousness
Lecture 5: Happiness and Prosperity – Current Scenario
Lecture 6: Method to Fulfil the Basic Human Aspirations
Tutorial 3: Practice Session -Exploring Natural Acceptance

Module 2 – Harmony in the Human Being

Lecture 7: Understanding Human being as the Co-existence of the Self and the Body
Lecture 8: Distinguishing between the Needs of the Self and the Body
Tutorial 4: Practice Session -Exploring the difference of Needs of Self and Body
Lecture 9: The Body as an Instrument of the Self
Lecture 10: Understanding Harmony in the Self
Tutorial 5: Practice Session -Exploring Sources of Imagination in the Self
Lecture 11: Harmony of the Self with the Body
Lecture 12: Programme to ensure self-regulation and Health
Tutorial 6: Practice Session -Exploring Harmony of Self with the Body

Module 3 – Harmony in the Family and Society

Lecture 13: Harmony in the Family – the Basic Unit of Human Interaction
Lecture 14: 'Trust' – the Foundational Value in Relationship
Tutorial 7: Practice Session -Exploring the Feeling of Trust
Lecture 15: 'Respect' – as the Right Evaluation
Tutorial 8: Practice Session- Exploring the Feeling of Respect Lecture 16: Other Feelings, Justice in Human-to-Human Relationship Lecture 17: Understanding Harmony in the Society
Lecture 18: Vision for the Universal Human Order
Tutorial 9: Practice Session -Exploring Systems to fulfil Human Goal

Module 4 – Harmony in the Nature/Existence

Lecture 19: Understanding Harmony in the Nature
Lecture 20: Interconnectedness, self-regulation and Mutual Fulfilment among the Four Orders of Nature
Tutorial 10: Practice Session -Exploring the Four Orders of Nature
Lecture 21: Realizing Existence as Co-existence at All Levels
Lecture 22: The Holistic Perception of Harmony in Existence
Tutorial 11: Practice Session -Exploring Co-existence in Existence

Module 5 – Implications of the Holistic Understanding – a Look at Professional Ethics Lecture 23: Natural Acceptance of Human Values
Lecture 24: Definitiveness of (Ethical) Human Conduct
Tutorial 12: Practice Session PS12 Exploring Ethical Human Conduct
Lecture 25: A Basis for Humanistic Education, Humanistic Constitution and Universal Human Order
Lecture 26: Competence in Professional Ethics
Tutorial 13: Practice Session PS13 Exploring Humanistic Models in Education
Lecture 27: Holistic Technologies, Production Systems and Management Models-Typical Case Studies
Lecture 28: Strategies for Transition towards Value-based Life and Profession
Tutorial 14: Practice Session PS14 Exploring Steps of Transition towards Universal Human Order.

The Textbook

1. A Foundation Course in Human Values and Professional Ethics, R R Gaur, R Asthana, G P Bagaria, 2nd Revised Edition, Excel Books, New Delhi, 2019. ISBN 978-93-87034- 47-1
2. Teachers' Manual for A Foundation Course in Human Values and Professional Ethics, RR Gaur, R Asthana, G P Bagaria, 2nd Revised Edition, Excel Books, New Delhi, 2019. ISBN 978-93-87034-53-
3. Professional Ethics and Human Values, Premvir Kapoor, ISBN: 978-93-86173-652, Khanna Book Publishing Company, New Delhi, 2022.

Reference Books

1. Jeevan Vidya: Ek Parichaya, A Nagaraj, Jeevan Vidya Prakashan, Amarkantak, 1999.
2. Human Values, A.N. Tripathi, New Age Intl. Publishers, New Delhi, 2004.
3. The Story of Stuff (Book).
4. The Story of My Experiments with Truth - by Mohandas Karamchand Gandhi
5. Small is Beautiful - E. F Schumacher.
6. Slow is Beautiful - Cecile Andrews
7. Economy of Permanence - J C Kumarappa
8. Bharat Mein Angreji Raj – Pandit Sunderlal
9. Rediscovering India - by Dharampal
10. Hind Swaraj or Indian Home Rule - by Mohandas K. Gandhi
11. India Wins Freedom - Maulana Abdul Kalam Azad
12. Vivekananda - Romain Rolland (English)
13. Gandhi - Romain Rolland (English)

COURSE OUTCOME:

CO1. Understand the role of values in achieving happiness and prosperity through right understanding and relationships.
CO2. Analyze harmony in self, family, society, and nature for ethical and responsible living.
CO3. Apply human values and ethics in professional and personal life for a value-based society.

Course Outcome No	Statement	Knowledge Level (KL)
CO1	Understand the role of values in achieving happiness and prosperity through right understanding and relationships.	K_1

CO2	Analyze harmony in self, family, society, and nature for ethical and responsible living.	K_4
CO3	Apply human values and ethics in professional and personal life for a value-based society.	K_3

KL- Bloom's Knowledge Level (K_1, K_2, K_3, K_4, K_5, K_6)

K_1-Remember, K_2- Understand, K_3- Apply, K_4- Analyze, K_5- Evaluate, K_6- Create

Course Articulation Matrix: (Mapping of COs with POs & PSOs)

CO	CORRELATION WITH PROGRAM OUTCOMES												CORRELATION WITH PSOs	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	3				2			2				1	1
CO2	1			2							1			
CO3	1	2												
CO(Average)	1.3	2.5		2		2			2		1		1	1

3 –High; 2 –Medium; 1 –Low

ENGINEERING CHEMISTRY LAB

Subject Code: -	**BTBSC202P**	**IA Marks**	**30**
Number of Lab Hours/Week: -	**02**	**Term End Exam Marks**	**20**
Total Number of Lecture Hours: -	**15**	**CREDITS**	**01**

Assessment Plan:

Criteria	Description	Maximum Marks
Internal Assessment (IA)	Internal Examination	20
	Attendance/Discipline	5
	Assignment/ Seminar	5
Terminal Examination (TE)	Terminal Examination	20
Total		50
Attendance	A minimum of 75% Attendance is required to be maintained by a student to be qualified for taking up the End Semester examination. The allowance of 25% includes all types of leaves including medical leaves.	

LABORATORY

1. Determination of surface tension and viscosity.
2. Thin layer chromatography.
3. Ion exchange column for removal of hardness of water.
4. Determination of chloride content of water.
5. Determination of the rate constant of a reaction.
6. Determination of cell constant and conductance of solutions.
7. Potentiometry - determination of redox potentials and EMFs.
8. Synthesis of a polymer/drug.

9. Saponification/acid value of an oil.
10. Chemical analysis of a salt.
11. Adsorption of acetic acid by charcoal.
12. Use of the capillary viscosimeters to the demonstrate of the isoelectric point as the pH of minimum viscosity for gelatin sols and/or coagulation of the white part of egg.

Text/Reference Books:

1. AICTE's Prescribed Textbook: Chemistry – I with Lab Manual (ISBN: 978-93-91505-141)
2. Engineering Chemistry, by Manisha Agrawal.
3. University chemistry, by B. H. Mahan.
4. Chemistry: Principles and Applications, by M. J. Sienko and R. A. Plane.
5. Fundamentals of Molecular Spectroscopy, by C. N. Banwell.
6. Engineering Chemistry (NPTEL Web-book), by B. L. Tembe, Kamaluddin and M. S. Krishnan.
7. Physical Chemistry, by P. W. Atkins.
8. A Textbook of Engineering Chemistry, Shashi Chawla.
9. Organic Chemistry: Structure and Function by K. P. C. Volhardt and N. E. Schore, 5th Edition http://bcs.whfreeman.com/vollhardtschore5e/default.asp

Laboratory Outcomes: The chemistry laboratory course will consist of experiments illustrating the principles of chemistry relevant to the study of science and engineering. The students will learn:

CO1. To estimate rate constants of reactions from concentration of reactants/products as a function of time.
CO2. To measure molecular/system properties such as surface tension, viscosity, conductance of solutions, redox potentials, chloride content of water, etc.
CO3. To synthesize a small drug molecule and analyze a salt sample.

Course Outcome No	Statement	Knowledge Level (KL)
CO1	To estimate rate constants of reactions from concentration of reactants/products as a function of time.	K_1
CO2	To measure molecular/system properties such as surface tension, viscosity, conductance of solutions, redox potentials, chloride content of water, etc.	K_2
CO3	To synthesize a small drug molecule and analyze a salt sample.	K_3

KL- Bloom's Knowledge Level (K_1, K_2, K_3, K_4, K_5, K_6)

K_1-Remember, K_2- Understand, K_3- Apply, K_4- Analyze, K_5- Evaluate, K_6- Create

Course Articulation Matrix: (Mapping of COs with POs & PSOs)

CO	CORRELATION WITH PROGRAM OUTCOMES												CORRELATION WITH PSOs	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	1										1		1	
CO2		2			1									
CO3			2				1				1			1
CO(Average)	1	2	2		1		1				1		1	1

3 –High; 2 –Medium; 1 –Low

ENGLISH FOR TECHNICAL WRITING LAB

Subject Code: - BTHSMC202P	**IA Marks 30**
Number of Lab Hours/Week: - 02	**Term End Exam Marks 20**
Total Number of Lecture Hours: - 15	**CREDITS 01**

Course Objectives

1. To improve fluency in spoken English and to practice correct pronunciation.
2. To introduce the techniques of presentation skills
3. Help improve speaking skills through participation in activities such as role plays, discussions, and structured talks/ oral presentations

Assessment Plan:

Criteria	Description	Maximum Marks
Internal Assessment (IA)	Internal Examination	20
	Attendance/Discipline	5
	Assignment/ Seminar	5
Terminal Examination (TE)	Terminal Examination	20
Total		50
Attendance	A minimum of 75% Attendance is required to be maintained by a student to be qualified for taking up the End Semester examination. The allowance of 25% includes all types of leaves including medical leaves.	

Module- I

The sounds of English

Practicing correct Pronunciation through IPA, Stress, Intonation, Rhythm

Module –II

Group Discussions

Purpose, Different roles for participants, Etiquette in a structured GD - Practice GDs

Module –III

Interpersonal Skills

1. Introduction of self and others, making announcements
2. Getting Someone's Attention, and Interrupting Conversations
3. Making Requests and Responding to them, asking for directions

Module –IV

Listening Skills

1. Listening to unknown passages – for global understanding, identifying key terms, understanding concepts and answering a series of relevant questions that test comprehension.

Module –V

Presentation skills

1. Oral Presentations (JAMs) 2. Describing and analysing videos and pictures.3. Interpreting and analysing data from graphs and charts

Course Outcomes

By the end of the course, the student will be able to:

CO1. Speak English with proper pronunciation and intonation
CO2. Make effective oral presentations by interpreting and analysing data, pictures and videos and participate in Group Discussion on general topics
CO3. Make meaningful conversations and follow logical flow of thought; answer questions on key concepts after listening to extended passages.

Course Outcome No	Statement	Knowledge Level (KL)
CO1	Speak English with proper pronunciation and intonation	K_1
CO2	Make effective oral presentations by interpreting and analysing data, pictures and videos and participate in Group Discussion on general topics	K_2
CO3	Make meaningful conversations and follow logical flow of thought; answer questions on key concepts after listening to extended passages.	K_3

KL- Bloom's Knowledge Level (K_1, K_2, K_3, K_4, K_5, K_6)

K_1-Remember, K_2- Understand, K_3- Apply, K_4- Analyze, K_5- Evaluate, K_6- Create

Course Articulation Matrix: (Mapping of COs with POs & PSOs)

CO	CORRELATION WITH PROGRAM OUTCOMES												CORRELATION WITH PSOs	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	1													
CO2		2		1			2		2				1	
CO3			2											1
CO(Average)	1	2	2	1			2		2				1	1

3 –High; 2 –Medium; 1 –Low

PROGRAMMING FOR PROBLEM SOLVING LAB

Subject Code: - BTESC204P	**IA Marks 30**
Number of Lab Hours/Week: - 04	**Term End Exam Marks 20**
Total Number of Lecture Hours: - 30	**CREDITS 02**

Course Objectives:

1. To learn the fundamentals of computers.
2. To understand the various steps in program development.
3. To learn the syntax and semantics of C programming language.

4. To learn the usage of structured programming approach in solving problems.
5. To understated and formulate algorithm for programming script
6. To analyze the output based on the given input variables

Assessment Plan:

Criteria	Description	Maximum Marks
Internal Assessment (IA)	Internal Examination	20
	Attendance/Discipline	5
	Assignment/ Seminar	5
Terminal Examination (TE)	Terminal Examination	20
Total		50
Attendance	A minimum of 75% Attendance is required to be maintained by a student to be qualified for taking up the End Semester examination. The allowance of 25% includes all types of leaves including medical leaves.	

PRACTICALS:

1. Familiarization with programming environment
2. Simple computational problems using arithmetic expressions
3. Problems involving if-then-else structures
4. Iterative problems e.g., sum of series
5. 1D Array manipulation
6. Matrix problems, String operations
7. Simple functions
8. Programming for solving Numerical methods problems
9. Recursive functions
10. Pointers and structures
11. File operations

EXPERIMENTS THAT MAY BE PERFORMED THROUGH VIRTUAL LABS:

S. No.	Experiment Name	Experiment Link(s)
1	Simple computational problems using arithmetic expressions.	http://ps-iiith.vlabs.ac.in/exp7/Introduction.html?domain=Computer%20Science&lab=Problem%20Solving%20Lab
2	Iterative problems e.g., sum of series.	http://ps-iiith.vlabs.ac.in/exp4/Introduction.html?domain=Computer%20Science&lab=Problem%20Solving%20Lab
3	1D Array manipulation.	http://cse02-iiith.vlabs.ac.in/exp4/index.html
4	Matrix problems, String operations.	http://ps-iiith.vlabs.ac.in/exp5/Introduction.html?domain=Computer%20Science&lab=Problem%20Solving%20Lab
5	Simple functions.	http://cse02-iiith.vlabs.ac.in/exp2/index.html

6	Programming for solving Numerical methods problems.	http://ps-iiith.vlabs.ac.in/exp1/Introduction.html?domain=Computer%20Science&lab=Problem%20Solving%20Lab
7	Recursive functions.	http://ps-iiith.vlabs.ac.in/exp6/Introduction.html?domain=Computer%20Science&lab=Problem%20Solving%20Lab

Course Outcomes

The student will learn following through Practicals:

1. To formulate the algorithms for simple problems.
2. To translate given algorithms to a working and correct program.
3. To be able to correct syntax errors as reported by the compilers.
4. To be able to identify and correct logical errors encountered at run time.
5. To be able to write iterative as well as recursive programs.
6. To be able to represent data in arrays, strings and structures and manipulate them through a program.
7. To be able to declare pointers of different types and use them in defining self-referential structures.
8. To be able to create, read and write to and from simple text files.

Course Outcome No	Statement	Knowledge Level (KL)
CO1	To formulate the algorithms for simple problems.	K_1
CO2	To translate given algorithms to a working and correct program.	K_2
CO3	To be able to correct syntax errors as reported by the compilers.	K_3
CO4	To be able to identify and correct logical errors encountered at run time.	K_1
CO5	To be able to write iterative as well as recursive programs.	K_1
CO6	To be able to represent data in arrays, strings and structures and manipulate them through a program.	K_2
CO7	To be able to declare pointers of different types and use them in defining self-referential structures.	K_2
CO8	To be able to create, read and write to and from simple text files.	K_6

KL- Bloom's Knowledge Level (K_1, K_2, K_3, K_4, K_5, K_6)

K_1-Remember, K_2- Understand, K_3- Apply, K_4- Analyze, K_5- Evaluate, K_6- Create

Course Articulation Matrix: (Mapping of COs with POs & PSOs)

CO	CORRELATION WITH PROGRAM OUTCOMES												CORRELATION WITH PSOs	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	3				2			2				1	1
CO2	3			2							1			
CO3		2						1						

CO4	1											1		
CO5				3										
CO6	3							3					3	
CO7					1									
CO8														
CO(Average)	2.3	2.5		2.5	1	2		2	2		1	1	2	1

3 –High; 2 –Medium; 1 –Low

WORKSHOP/MANUFACTURING PRACTICES LAB

Subject Code: - BTESC206P	**IA Marks 30**
Number of Lab Hours/Week: - 04	**Term End Exam Marks 20**
Total Number of Lecture Hours: - 30	**CREDITS 02**

Course Objective:

1. To provide exposure to the students with hands on experience on various basic engineering practices in Civil, Mechanical, Electrical and Electronics Engineering.
2. To have a study and hands-on-exercise on plumbing and carpentry components.
3. To have a practice on gas welding, foundry operations and fitting
4. To have a study on measurement of electrical quantities, energy and resistance to earth.
5. To have a practice on soldering.

Assessment Plan:

Criteria	Description	Maximum Marks
Internal Assessment (IA)	Internal Examination	20
	Attendance/Discipline	5
	Assignment/ Seminar	5
Terminal Examination (TE)	Terminal Examination	20
Total		50
Attendance	A minimum of 75% Attendance is required to be maintained by a student to be qualified for taking up the End Semester examination. The allowance of 25% includes all types of leaves including medical leaves.	

Course Content:

Module I: Manufacturing Methods- casting, forming, machining, joining, advanced manufacturing methods.
Module II: CNC machining, Additive manufacturing.
Module III: Fitting operations & power tools.
Module IV: Electrical & Electronics.
Module V: Carpentry.
Module VI: Plastic moulding, glass cutting.
Module VII: Metal casting.
Module VIII: Welding (arc welding & gas welding), brazing.

Practical's:

1. Machine shop
2. Fitting shop
3. Carpentry
4. Electrical & Electronics
5. Welding shop (Arc welding + Gas welding)
6. Casting
7. Smithy
8. Plastic moulding & Glass Cutting

Examinations could involve the actual fabrication of simple components, utilizing one or more of the techniques covered above.

Suggested Text/Reference Books:

1. AICTE's Prescribed Textbook: Workshop / Manufacturing Practices (with Lab Manual) ISBN: 978-93-91505-332
2. Hajra Choudhury S.K., Hajra Choudhury A.K. and Nirjhar Roy S.K., "Elements of Workshop Technology", Vol. I 2008 and Vol. II 2010, Media promoters and publishers private limited, Mumbai.
3. Kalpakjian S. And Steven S. Schmid, "Manufacturing Engineering and Technology", 4th edition, Pearson Education India Edition, 2002.
4. Gowri P. Hariharan and A. Suresh Babu," Manufacturing Technology – I" Pearson Education, 2008.
5. Roy A. Lindberg, "Processes and Materials of Manufacture", 4th edition, Prentice Hall India, 1998.
6. Rao P.N., "Manufacturing Technology", Vol. I and Vol. II, Tata McGraw Hill House, 2017.

EXPERIMENTS THAT MAY BE PERFORMED THROUGH VIRTUAL LABS:

S. No.	Experiment Name	Experiment Link(s)
1	Welding shop (Arc welding + Gas welding).	http://mm-coep.vlabs.ac.in/LaserSpotWelding/Theory.html?domain=Mechanical%20Engineering&lab=Welcome%20to%20Micromachining%20laboratory
2	Casting	http://fab-coep.vlabs.ac.in/exp7/Theory.html?domain=Mechanical%20Engineering&lab=Welcome%20to%20FAB%20laboratory

Laboratory Outcomes:

Upon completion of this laboratory course, students will be able:

1. To fabricate components with their own hands.
2. To relate practical knowledge of the dimensional accuracies and dimensional tolerances possible with different manufacturing processes.
3. To design small devices of their interest by assembling different components.

Course Outcome No	Statement	Knowledge Level (KL)
CO1	To fabricate components with their own hands.	K_1
CO2	To relate practical knowledge of the dimensional accuracies and dimensional tolerances possible with different manufacturing processes.	K_2
CO3	To design small devices of their interest by assembling different components.	K_3

KL- Bloom's Knowledge Level (K_1, K_2, K_3, K_4, K_5, K_6)

K_1-Remember, K_2- Understand, K_3- Apply, K_4- Analyze, K_5- Evaluate, K_6- Create

Course Articulation Matrix: (Mapping of COs with POs & PSOs)

CO	CORRELATION WITH PROGRAM OUTCOMES												CORRELATION WITH PSOs	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	3				2			2				1	1
CO2	1			2							1			
CO3	1	2												
CO(Average)	1.3	2.5		2		2			2		1		1	1

3 –High; 2 –Medium; 1 –Low

SEMESTER-III

MATHEMATICS-3 (PDE, PROB/STAT)

Subject Code: -	**BTBSC301**	**IA Marks**	**40**
Number of Lecture Hours/Week:-	**04**	**Term End Exam Marks**	**60**
Total Number of Lecture Hours: -	**60**	**CREDITS**	**04**

Course Objectives: To introduce the solution methodologies for second order Partial Differential Equations with applications in engineering. To provide an overview of probability and statistics to engineers.

Criteria	Description	Maximum Marks
Internal Assessment (IA)	Internal Examination	30
	Attendance/Discipline	5
	Assignment/ Seminar	5
Terminal Examination (TE)	Terminal Examination	60
Total		100
Attendance	A minimum of 75% Attendance is required to be maintained by a student to be qualified for taking up the End Semester examination. The allowance of 25% includes all types of leaves including medical leaves.	

Course Content:

Module -1 (15 hours)

Definition of Partial Differential Equations, First order partial differential equations, solutions of first order linear PDEs; Solution to homogenous and non-homogenous linear partial differential equations of second order by complimentary function and particular integral method. Second-order linear equations and their classification, Initial and boundary conditions, D'A lembert's solution of the wave equation; Duhamel's principle for one dimensional wave equation.

Module -2 (10 hours)

Heat diffusion and vibration problems, Separation of variables method to simple problems in Cartesian coordinates. The Laplacian in plane, cylindrical and spherical polar coordinates, solutions with Bessel functions and Legendre functions. One dimensional diffusion equation and its solution by separation of variables.

Module -3 (15 hours)

Probability spaces, conditional probability, independence; Discrete random variables, Independent random variables, the multinomial distribution, Poisson approximation to the binomial distribution, infinite sequences of Bernoulli trials, sums of independent random variables; Expectation of Discrete Random Variables, Moments, Variance of a sum, Correlation coefficient, Chebyshev's Inequality. Continuous random variables and their properties, distribution functions and densities, normal, exponential and gamma densities. Bivariate distributions and their properties, distribution of sums and quotients, conditional densities, Bayes' rule.

Module -4 (10 hours)

Basic Statistics, Measures of Central tendency: Moments, skewness and Kurtosis - Probability distributions: Binomial, Poisson and Normal - evaluation of statistical parameters for these three distributions, Correlation and regression – Rank correlation. Curve fitting by the method of least

squares- fitting of straight lines, second degree parabolas and more general curves.

Module -5 (10 hours)
Test of significance: Large sample test for single proportion, difference of proportions, Tests for single mean, difference of means, and difference of standard deviations. Test for ratio of variances - Chi- square test for goodness of fit and independence of attributes

Textbooks/References:
1. AICTE Prescribed Textbook: Mathematics – II (Probability and Statistics), ISBN: 978-93-91505 41-7
2. Reena Garg, Engineering Mathematics, Khanna Book Publishing Company, 2022.
3. Reena Garg, Advanced Engineering Mathematics, Khanna Book Publishing Company, 2021.
4. Erwin Kreyszig, Advanced Engineering Mathematics, 9th Edition, John Wiley & Sons, 2006. 5. N.P. Bali and Manish Goyal, A text book of Engineering Mathematics, Laxmi Publications, Reprint, 2010. 81 AICTE revised Model Curriculum for UG Degree Course in Mechanical Engineering
6. P. G. Hoel, S. C. Port and C. J. Stone, Introduction to Probability Theory, Universal Book Stall, 2003 (Reprint)
7. S. Ross, A First Course in Probability, 6th Ed., Pearson Education India, 2002.

COURSE OUTCOME:
Students will be able to solve PDEs, apply probability distributions, and analyze statistical data.
The students will learn:
CO 1. Understand basic concepts of PDE, probability, and statistics
CO 2. Apply intermediate techniques in PDE, probability distributions, correlation, and regression.
CO 3. Apply advanced statistical methods and solve real-world problems using PDE.

Course Outcome No	Statement	Knowledge Level (KL)
CO1	Understand basic concepts of PDE, probability, and statistics	K_1
CO2	Apply intermediate techniques in PDE, probability distributions, correlation, and regression	K_2
CO3	Apply advanced statistical methods and solve real-world problems using PDE.	K_3

KL- Bloom's Knowledge Level (K_1, K_2, K_3, K_4, K_5, K_6)
K_1-Remember, K_2- Understand, K_3- Apply, K_4- Analyze, K_5- Evaluate, K_6- Create

Course Articulation Matrix: (Mapping of COs with POs & PSOs)

CO	CORRELATION WITH PROGRAM OUTCOMES												CORRELATION WITH PSOs	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3						1		1					
CO2		1	2											
CO3				3									1	
CO(Average)	3	1	2	3			1		1				1	

3 –High; 2 –Medium; 1 –Low

MINERAL PROCESSING

Subject Code: -	**BTMT302**	**IA Marks**	**40**
Number of Lecture Hours/Week:-	**03**	**Term End Exam Marks**	**60**
Total Number of Lecture Hours: -	**45**	**CREDITS**	**03**

Course Objectives:

1. Introduce students to the principles of ore commination, liberation and particle size analysisand the different equipment used in the processes.
2. Teach the students about various methods of concentration/ separation and the processessuitable to the liberated ore and equipment used.
3. Acquaint the students about quantifying concentration processes and selection of propermineral dressing cycles for an ore/mineral.

Criteria	Description	Maximum Marks
Internal Assessment (IA)	Internal Examination	30
	Attendance/Discipline	5
	Assignment/ Seminar	5
Terminal Examination (TE)	Terminal Examination	60
Total		100
Attendance	A minimum of 75% Attendance is required to be maintained by a student to be qualified for taking up the End Semester examination. The allowance of 25% includes all types of leaves including medical leaves.	

COURSE CONTENT

Module–1 (10 hours)

Scope, objectives and advantages of ore dressing. Sampling of ores by different methods. Theory of liberation of minerals. Crushers**:** Jaw, Gyratory, Cone, Roll crushers. Types of grinding operations- batch and continuous, dry and wet grinding and open circuit and closed-circuit grinding. Grinding Mills**:** Ball mills, theory of ball mill operation and rod mill. Comminution laws: - Rittinger's laws, Kick's law and Bond's law.

Module–2 (10 hours)

Sizing Techniques: Laboratory and industry practices- Study of laboratory sizing techniques and reporting of sizing data. Types of screens, Movement of solids in fluids: Stokes and Newton's laws. Terminal velocity and its relation with size. Relation between time and velocity. Relation between distance traveled and velocity. Equal settling ratio, Free and hindered settling ratio. Quantifying concentrating operations: Ratio of concentration, recovery, selectivity index and economic recovery.

Module–3 (10 hours)

Classification and types of classifiers**:** Study of settling cones, rake classifier, spiral classifier and cyclones. Heavy media separation: Principles, flow chart, different media used. Heavy

media separation using heavy liquids and heavy suspensions. Jigging: Theory of jigging and Jigging machines**:** Harz, Baum, Denver jig.

Module -4 (05 hours)

Tabling- Basic principle, study of stratification on a table, Wilfred Table. Basic principles of Magnetic separation processes and electrostatic separation process. Brief description about the working of belt and drum magnetic separator, high tension separator.

Module –5 (10 hours)

Floatation: Principles of floatation. Factors affecting floatation. Classification of collectors and frothers. Regulators, factors affecting their efficiency. Floatation machines: Pneumatic and mechanical floatation cells.

Course Outcomes:

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

Course Outcome No	Statement	Knowledge Level (K)
CO1	Recognise of the need of the mineral dressing prior to extraction of metals.	K1
CO2	Describe the working and construction details of various equipments used in mineraldressing.	K3
CO3	Assess the efficiency of concentration processes.	K6
CO4	Select and describe a particular concentration process suitable to the liberated ore.	K2
CO5	To make a logical link between mineral processing and economics of metal production.	K3
CO6	Apply the knowledge learned so as to being capable of understanding advance courses inmineral processing operations and modeling.	K3

KL – Bloom's Knowledge Level (K_1, K_2, K_3, K_4, K_5, K_6)

K_1- Remember, K_2 – Understand, K_3 – Apply, K_4 – Analyze, K_5- Evaluate, K_6 – Create

Course Articulation Matrix: (Mapping of COs with POs & PSOs)

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3			3				2	1			
CO2	2				1		1	3	3			
CO3	3		2	3				1	1			
CO4												
CO5												
CO6												
CO Average	2.66		2	3	1		1	2	1.66			

3 - High; 2 - Medium; 1 – Low

Text Books:

1. Mineral Processing Technology - Barry A. Wills, James Finch Published by Butterworth-Heinemann, 2015.
2. Principles of Mineral Dressing - A.M. Gaudin, published by McGraw-Hill Inc., US, 1939.

References Books:

1. Text book of Mineral processing by D.V. Subba Rao, Scientific Publishers, 2007.
2. Ore dressing practices - S. K. Jain, Rotterdam: A.A. Balkema, 1987.
3. Elements of Ore Dressing by A.F. Taggart, John Wiley & Sons,1st Edition ,1951.

METALLURGICAL THERMODYNAMICS –I

Subject Code: -	**BTMT303**	**IA Marks**	**40**
Number of Lecture Hours/Week: -	**04**	**Term End Exam Marks**	**60**
Total Number of Lecture Hours: -	**60**	**CREDITS**	**04**

Course Objectives:

1. The prime aim of this course is to apply thermodynamics and kinetics to various metallurgical aspects like Solutions, Phase diagrams and Ellingham Diagrams.
2. The course is also intended to correlate electrochemical principles with thermodynamics.
3. To provide a consistent picture of thermodynamic concepts when applied to various topics

Module-1 (10 hours)

Objectives and limitations to thermodynamics, concepts of system and state, heterogeneous and homogeneous systems, extensive and intensive properties of system, thermodynamic variables, thermodynamic equilibrium and Zeroth law of thermodynamics. Reversible and irreversible processes.

Module-2 (10 hours)

First Law of thermodynamics: Relationship between heat and work, internal energy and the first law of thermodynamics, calculations of work, Heat capacity, reversible adiabatic processes, reversible isothermal pressure or volume changes, of an ideal gas, Joules experiment, Joule- Thompson experiment, Joule-Thompson co-efficient, Enthalpy change with temperature, Kirchhoff's equation. Efficiency of a cyclic process, Carnot cycle, Carnot theorem, Second law of thermodynamics, concept of entropy, Quantification of irreversibility.

Module-3 (10 hours)

Free energy functions: Purposes of the new functions, definition of Helmholtz and Gibbs free energy change, meaning of thermodynamically possible process, determination of □G from thermal data, useful relationships between free energies and other thermodynamic functions, Maxwell's equations and Gibbs-Helmholtz equation.

Module-4 (15 hours)

Third law of thermodynamics: Background of third law, deductions from third law, applications of third law, other methods of obtaining ΔS^0 for a reaction

Fugacity, activity and equilibrium constant: Concepts of fugacity, activity and equilibrium constant variation of the equilibrium constant with temperature, sigma functions.

Module-5 (15 hours)

Claussius – Clapeyron equation: Introduction, derivation of the Claussius – Clapeyron equation for single substance, Troutons Rule and Ramsay Young Rule, Duhring rule for the estimation of the vapour pressures of an element, Integration of Claussius – Clapeyron equation.

Course Outcomes:

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

CO1. Understanding and applying fundamental thermodynamic concepts and laws
CO2. Utilizing thermodynamic relations to predict and solve problems in metallurgical processes.
CO3. Grasping the concept of energy, entropy, and their applications in materials science.
CO4. Interpreting and applying Ellingham diagrams for oxide formation and reduction.

Course Outcome No	Statement	Knowledge Level (K)
CO1	understanding and applying fundamental thermodynamic concepts and laws	K1
CO2	utilizing thermodynamic relations to predict and solve problems in metallurgical processes	K3
CO3	grasping the concept of energy, entropy, and their applications in materials science	K6
CO4	interpreting and applying Ellingham diagrams for oxide formation and reduction	K4

KL – Bloom's Knowledge Level (K_1, K_2, K_3, K_4, K_5, K_6)
K_1- Remember, K_2 – Understand, K_3 – Apply, K_4 – Analyze, K_5- Evaluate, K_6 – Create

Course Articulation Matrix: (Mapping of COs with POs & PSOs)

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3			3				2	1			
CO2	2				1		1	3	3			
CO3	3		2	3				1	1			
CO4												
CO Average	2.66		2	3	1		1	2	1.66			

3 - High; 2 - Medium; 1 – Low

Text Books:

1. Introduction to Metallurgical Thermodynamics – D.R. Gaskell, hemisphere Publishing Corporation, 1981.
2. Chemical and Metallurgical Thermodynamics (Vol I &II) - M.L. Kapoor, Nemchand & Bros Publishers, 1984.

Reference Books:

1. Physical chemistry for Metallurgists – J. Mackowiak, Allen & Unwin, 2nd edition, 1967.
2. Thermodynamics of solids- R.S. Swalin, John Wiley Publisher, 1972.
3. Physical chemistry of metals- L.S. Darken & Gurry, CBS publishers & Distributors 2002.
4. Problems in Metallurgical Thermodynamics: G.S Upadhyaya, R.K. Dubey, Elsevier Science, 2013.

Course Outcomes:

At the end of the course the student would be able to:

1. Knowledge of the type of variable that affects heterogeneous reaction rates nucleation, interfacial energy, interface equilibrium and diffusion.
2. Relate 1st and 2nd Law of thermodynamics.
3. Knowledge of enthalpy, entropy and free energy.
4. Understand the principles of kinetics and thermodynamics as applied to rates and equilibrium positions of chemical reactions.
5. Calculate the temperature dependence of rate constants and relate this calculation to activity and fugacity.

PRINCIPLES OF EXTRACTIVE METALLURGY

Subject Code: -	**BTMT304**	**IA Marks**	**40**
Number of Lecture Hours/Week:-	**03**	**Term End Exam Marks**	**60**
Total Number of Lecture Hours: -	**45**	**CREDITS**	**03**

Pre-Requisites: Mineral Processing and Metallurgical Thermodynamics-I

Course Objectives:

1. To learn and emphasize the principles of pyro metallurgy, hydrometallurgy and electrometallurgy.
2. To learn scientific concepts of extraction and refining.
3. Obtain knowledge of equipment used in pyro metallurgy, hydrometallurgy and electrometallurgy.
4. Gain basic knowledge about palletization and Sintering

Module -1 (10 hours)

Introduction: Classification of ores. Basics of Pyrometallurgy, Calcination, Roasting and types of roasting, Oxidising, sulphatising, and chloridizing. Roasting furnaces: Multiple hearth roaster, flash roasting, fluidized bed roasting and blast roasting.

Module -2 (10 hours)
Pelletisation and Sintering, Smelting: Principles of reduction and matte smelting with examples. Smelting furnaces: Reverberatory, Blast Furnace and electric smelting. Flash smelting.
Slags: Classification, properties, Application of Ellingham diagrams for oxides and sulphides.

Module -3 (10 hours)
Hydrometallurgy: Flowchart, Principles and types of leaching, Advantages and limitations, Solution purification by ion and solvent exchange methods, Metal recovery from leach solution by cementation.

Module -4 (05 hours)
Classification of electrometallurgy, Principles of electrometallurgy, Advantages and limitations of electrometallurgy, Electro winning and Electro refining with typical examples.

Module -5 (10 hours)
Principles of Refining: Fire refining, Distillation, liquation, electro-refining and zone refining with some examples.

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

CO1. Classify the different ores and describe the various units operating like pyro metallurgy, hydrometallurgy and electrometallurgy.
CO2. Differentiate the various types of slags, properties and their applications.
CO3. Illustrate with the help of flow sheet of process taking place in pyro metallurgy, hydrometallurgy and electrometallurgical extractions of metal/matte.
CO4. Choose the type of refining process according purity required.
CO5. Understand the impact of extractive process on health environment society and will be able to suggest suitable techniques to recycle the byproducts or to decrease energy consumptions.
CO6. Design the suitable process for extraction.

Course Outcome No	Statement	Knowledge Level (KL)
CO1	Classify the different ores and describe the various units operating like pyro metallurgy, hydrometallurgy and electrometallurgy.	K1
CO2	Differentiate the various types of slags, properties and their applications.	K3
CO3	Illustrate with the help of flow sheet of process taking place in pyro metallurgy, hydrometallurgy and electrometallurgical extractions of metal/matte.	K6
CO4	Choose the type of refining process according purity required.	K4
CO5	Understand the impact of extractive process on health environment society and will be able to suggest suitable techniques to recycle the byproducts or to decrease energy consumptions.	K2
CO6	Design the suitable process for extraction.	K3

KL – Bloom's Knowledge Level (K_1, K_2, K_3, K_4, K_5, K_6)
K_1- Remember, K_2 – Understand, K_3 – Apply, K_4 – Analyze, K_5- Evaluate, K_6 – Create

Course Articulation Matrix: (Mapping of COs with POs & PSOs)

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3			3				2	1			
CO2	2				1		1	3	3			
CO3	3		2	3				1	1			
CO4												
CO5												
CO6												
CO Average	2.66		2	3	1		1	2	1.66			

3 - High; 2 - Medium; 1 – Low

Text Books:

1. Non-ferrous extractive metallurgy: H.S.Ray, K.P.Abraham and R.Sreedhar, Affiliated East West Private Limited, 2008.
2. Principles of extractive metallurgy - H.S. Ray & A. Ghosh, New - Age International Publisher, 3rd Edition, 2018.

Reference Books:

1. Extractive Metallurgy: Process and Applications: Sujay Kumar Dutta, Avinash B. Lele and Yakshil B. Chokshi, PHI Learning Pvt. Ltd., 2018.
2. A text book of metallurgy - A. R. Bailey, Macmillan & Co, 1st edition, 1960.
3. Principles of extractive metallurgy - Terkel Rosenqvist, Tapir Academic Press, 2004.

TESTING OF MATERIALS

Subject Code: -	**BTESC305**	**IA Marks**	**40**
Number of Lecture Hours/Week:-	**03**	**Term End Exam Marks**	**60**
Total Number of Lecture Hours: -	**45**	**CREDITS**	**03**

Course Objectives:

The primary objectives of this course are to:

1. Introduce various types of engineering materials and their mechanical behavior under different loading conditions.
2. Familiarize students with standard testing methods used to evaluate mechanical properties such as strength, ductility, hardness, toughness, fatigue, and creep.
3. Develop an understanding of fracture mechanisms in materials and the significance of different fracture modes.

Module -1 (07 hours)

Introduction : Type of engineering materials and their applications, testing of materials for evaluation, characterization and selection of various applications. Types of testing systems, significance of measurement of properties and test conditions, interpretation of test results.

Module -2 (10 hours)

Tensile Testing : Scope of tensile testing and significance of parameters measured in the test Necking during tension test, instability in tension, diffuse necking, stress distribution at the neck, ductility measurement in tensile testing – effect of gauge length. Effect of strain rate and temperature on flow properties. Machine stiffness in tensile testing systems, measuring instrument computerization.

Module -3 (10 hours)

Torsion Test: Mechanical properties in torsion. Torsional stresses for large plastic deformation, torsional failure, torsion Vs. tension test.

Hardness Test: Hardness testing system, elastic and plastic behavior during hardness testing. General consideration such as indenter size, shape, friction type of loading etc. in hardness testing. Concept of micro hardness. Major hardness testing systems such as Rockwell, Brinell, Vickers. Special hardness tests such as superficial, micro and shore.

Module -4 (08 hours)

Elements of brittle fracture elliptical crack and Griffith theory of Brittle fracture. Ductile to brittle transition. Notch effective in fracture. Impact testing for brittle fracture. Notched bar tests, instrumented charpy test. Drop weight crack arrest test, Introduction to fracture toughness testing.

Module -5 (10 hours)

Fatigue Tests : Stress cycles and SN curve statistical nature of fatigue. Effect of mean strain concentration, size and surface condition on fatigue. Fatigue testing machines and equipment's. Creep stress rupture tests. Creep cure and its analysis. Stress rupture test. Presentation of engineering creep data. Equipment test set up in creep testing.

Non-destructive Testing: Methods and classification. Elements and instrument in visual magnetic, radiographic, ultrasonic, electromagnetic, penetrant tests, their applications in quality control and inspection**.**

Text Books :

1. George E.D.; Mechanical Metallurgy; McGraw Hill Publication, UK, 1988.
2. Raj Baldev, Jayakumar T., Practical Non-Destructive Testing; Narosa Publisher, New Delhi, 1997.

Reference Books :

1 Metal Hand Book; 9th Edition Vol-8; Mechanical Testing; ASM International, 1985
2 Davis H.E., Testing of Engineering Materials, McGraw Hill Publication, 1982.

Course Outcomes:

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

1. Identify different types of engineering materials and describe their applications based on mechanical properties.
2. Perform tensile tests and analyze the behavior of materials under uniaxial tension, considering parameters such as strain rate, temperature, and machine stiffness.
3. Compare and interpret the results of torsion and hardness tests, including Rockwell, Brinell, and Vickers methods, and explain the influence of test parameters on results.
4. Explain the mechanisms of brittle and ductile fracture, and conduct impact tests like the Charpy and drop weight tests to evaluate fracture toughness.
5. Analyze fatigue and creep behavior of materials through SN curves and creep curves, and interpret long-term material performance under cyclic and high-temperature loading.

Course Outcome No	Statement	Knowledge Level (K)
CO1	Identify different types of engineering materials and describe their applications based on mechanical properties.	K1
CO2	Perform tensile tests and analyze the behavior of materials under uniaxial tension, considering parameters such as strain rate, temperature, and machine stiffness.	K3
CO3	Compare and interpret the results of torsion and hardness tests, including Rockwell, Brinell, and Vickers methods, and explain the influence of test parameters on results.	K6
CO4	Explain the mechanisms of brittle and ductile fracture, and conduct impact tests like the Charpy and drop weight tests to evaluate fracture toughness.	K4
CO5	Analyze fatigue and creep behavior of materials through SN curves and creep curves, and interpret long-term material performance under cyclic and high-temperature loading.	K3

KL – Bloom's Knowledge Level (K_1, K_2, K_3, K_4, K_5, K_6)
K_1- Remember, K_2 – Understand, K_3 – Apply, K_4 – Analyze, K_5- Evaluate, K_6 – Create

Course Articulation Matrix: (Mapping of COs with POs & PSOs)

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3			3				2	1			
CO2	2				1		1	3	3			
CO3	3		2	3				1	1			
CO4												
CO5												
CO6												
CO Average	2.66		2	3	1		1	2	1.66			

3 - High; 2 - Medium; 1 – Low

PHYSICAL METALLURGY

Subject Code: -	**BTMT306**	**IA Marks**	**40**
Number of Lecture Hours/Week:-	**03**	**Term End Exam Marks**	**60**
Total Number of Lecture Hours: -	**45**	**CREDITS**	**03**

Course Objectives:

1. Give basic concepts of material science.
2. The prime objective of this course is to make the student gain an understanding of the relation between microstructural characteristics and properties of metals and alloys.
3. The course also critically focuses on the crystallography, phase transformations that occur in several ferrous and nonferrous metallurgical systems as a function of temperature and composition through phase equilibrium diagrams.

Module –1 (07 hours)

Structure of Metals, Types of chemical bonding, crystal systems, plane and directional indices, transformation of indices, coordination number, relationship between lattice parameter and atomic radius, packing factor and density calculations, interstitial voids.

Module –2 (10 hours)

Diffusion: Fick's laws of diffusion and its applications, Kirkendall effect, Darken's equations, the Matano Method. Determination of intrinsic diffusivities, self diffusion in pure metals, Temperature dependence of the diffusion coefficient, diffusion along the grain boundaries and surfaces.

Module–3 (10 hours)

Types of nucleation, determination of the size of critical nucleus, equilibrium cooling and heating of alloys.

Constitution of Alloys: Necessity of alloying, types of solid solutions, Hume-Rothery's rules. Intermediate alloy phases, electron-chemical compounds and electron phases.

Equilibrium Diagrams: Construction, lever rule, phase rule.

Module–4 (10 hours)

Types of Phase diagrams: Binary Isomorphous alloy systems, non- equilibrium cooling. Binary eutectic system, peritectic and monotectic reactions, miscibility gaps. Phase diagrams with intermediate phases and compounds Transformation in solid state: allotropy, eutectoid, peritectoid reactions and order-disorder transformations.

Module-5 (08 hours)

Study of Fe-Fe3 C phase diagram. Study of other important binary phase diagrams: Al-Cu, Cu-Zn, Cu-Sn, Pb-Sn, and complex phase diagrams. Strengthening mechanisms: strengthening of grain boundary, work hardening, solid solution strengthening, precipitation hardening and dispersion strengthening.

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

CO1. Analyze the structure of crystalline materials and calculate the various crystals parameters.
CO2. Explain the working of metallurgical microscope and its different parts.
CO3. Explain the necessity of alloys, will identify the different types of alloy phases.
CO4. Explain the construction and identification of phase diagrams and reactions.
CO5. Explain the Fe-Fe3C diagram with invariant reactions.
CO6. Explain the Cu-Zn and other binary diagrams and complex phase diagrams etc.

Course Outcome No	Statement	Knowledge Level (K)
CO1	Analyze the structure of crystalline materials and calculate the various crystals parameters.	K1
CO2	Explain the working of metallurgical microscope and its different parts.	K3
CO3	Explain the necessity of alloys, will identify the different types of alloy phases.	K6
CO4	Explain the construction and identification of phase diagrams and reactions.	K4
CO5	Explain the Fe-Fe_3C diagram with invariant reactions.	K3
CO6	Explain the Cu-Zn and other binary diagrams and complex phase diagrams etc.	K4

KL – Bloom's Knowledge Level (K_1, K_2, K_3, K_4, K_5, K_6)
K_1- Remember, K_2 – Understand, K_3 – Apply, K_4 – Analyze, K_5- Evaluate, K_6 – Create

Course Articulation Matrix: (Mapping of COs with POs & PSOs)

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3			3				2	1			
CO2	2				1		1	3	3			
CO3	3		2	3				1	1			
CO4												
CO5												
CO6												
CO Average	2.66		2	3	1		1	2	1.66			

3 -High; 2 -Medium; 1 –Low

Text Books:

1. Materials Science and Engineering, An introduction. WD Callister, Jr., Adapted by R. Balasubramaniam, John Wiley & Sons, NY, Indian edition, 2007.
2. Introduction to Physical Metallurgy – SH Avner, TATA Mc GRAW HILL,1997.

Reference Books:

1. Physical Metallurgy Principles- R.E. Reed Hill, Affiliated East-West Press, 2008.
2. Physical Metallurgy - V. Raghavan, PHI Learning; 3rd edition, 2015.
3. Physical Metallurgy - Vijendra Singh, Standard Publishers Distributors, 2020.
4. Foundations of Materials Science and Engineering – WF Smith McGraw-Hill Education, 5th edition 2009.
5. Metallurgy for Engineers- Clark and Varney, Van Nostrand Reinhold Company, 2nd Revised edition, 1962.

MINERAL PROCESSING LAB

Subject Code: -	**BTMT302P**	**IA Marks**	**30**
Number of Lecture Hours/Week:-	**02**	**Term End Exam Marks**	**20**
Total Number of Lecture Hours: -	**30**	**CREDITS**	**01**

Course Objectives:

This laboratory course is designed to

1. To teach the student how to conduct sampling and sieve analysis.
2. Make the student to learn and demonstrate the usage of crushers and grinders.
3. Learn to conduct concentration methods at laboratory scale.
4. Teach the students how to note down the observations and results obtained in the experiments.

List of Experiments:

1. Sampling of an ore from the bulk by
   (i) Coning and quartering method.
   (ii) Riffle sampler.
2. Determination of average particle size of a given material by sieve analysis.
3. Verification of Stoke's Law.
4. Size reduction of the given material using Jaw Crusher and determining the reduction ratio.
5. Size reduction of the given material using Roll Crusher and determining the reduction ratio.
6. Size reduction of the given material using Ball Mill and determining the reduction ratio.
7. Determine the grindability index of coal using hard groove grindability machine.
8. Separation of the given material into magnetic and non magnetic particles using magnetic separator.
9. Determination of recovery percentage of the concentrate by Froth- Floatation process.
10. Study of a jigging machine.

Course Outcomes:

At the end of the laboratory course the student will be able to:

1. Pick or take a representative amount of sample and conduct experiments / tests.
2. Determine the reduction ratio in crushing and grinding of different materials using various

types of size reduction units.
3. Analyze the grindability of different coals.
4. Separate or concentrate the given materials using magnetic separation and froth flotation processes.
5. Prepare formal laboratory reports.

TESTING OF MATERIALS LAB

Subject Code: -	**BTMT305P**	**IA Marks**	**30**
Number of Lecture Hours/Week:-	**02**	**Term End Exam Marks**	**20**
Total Number of Lecture Hours: -	**30**	**CREDITS**	**01**

Course Objectives

The primary objectives of this laboratory course are to:

1. Familiarize students with the principles, operation, and applications of various mechanical and non-destructive testing techniques.
2. Develop hands-on skills in conducting hardness, tensile, and impact tests using standard testing machines.
3. Understand the influence of parameters such as temperature and strain rate on mechanical properties of materials.
4. Introduce students to microstructural effects on mechanical behavior through microhardness testing.
5. Provide exposure to non-destructive evaluation (NDE) techniques like ultrasonic flaw detection and magnetic particle testing.

List of Experiments:

1. Hardness Testing on “Rockwell Hardness Tester”.
2. Hardness Testing on “Vickers Hardness Tester”.
3. Hardness Testing on “Microhardness Tester”.
4. Hardness Testing on “Brinnel Hardness Tester”.
5. Tensile Testing.
6. Effect of Temperature on Tensile Properties.
7. Impact of Testing on Charpy.
8. Effect of Temperature on Impact Strength and Model of Fracture.
9. Effect of Strain Rate on Tensile Properties.
10. Demonstration of Ultrasonic Flaw Detector.
11. Demonstration of Magnetic Particle Testing.

Course Outcomes

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

CO1. Perform hardness tests using Rockwell, Vickers, Brinell, and Microhardness testers and interpret results as per standard practices.
CO2. Conduct tensile tests and evaluate mechanical properties such as yield strength, tensile strength, elongation, and modulus of elasticity.
CO3. Analyze the effect of temperature and strain rate on tensile properties and interpret the changes in stress–strain behavior.
CO4. Perform Charpy impact tests and evaluate the influence of temperature on impact strength and fracture mode.
CO5. Apply non-destructive testing methods like ultrasonic flaw detection and magnetic particle

testing to identify internal and surface defects.

PHYSICAL METALLURGY LAB

Subject Code: -	**BTMT306P**	**IA Marks**	**30**
Number of Lecture Hours/Week:-	**02**	**Term End Exam Marks**	**20**
Total Number of Lecture Hours: -	**30**	**CREDITS**	**01**

Course Objectives:

The laboratory course helps to:

1. Gain skills of preparation of samples for metallographic examinations.
2. Find and analyze the microstructures of various ferrous and non ferrous materials.
3. Use the suitable metallurgical microscope with suitable magnification.

List of Experiments:

1. Preparation and study of Crystal models.
2. Study of various microscopes (Optical microscope, SEM, TEM) and specimen preparation techniques for metallurgical microscope.
3. Metallographic preparation and microstructure evaluation of low carbon steel.
4. Metallographic preparation and microstructure evaluation of medium carbon steel.
5. Metallographic preparation and microstructure evaluation of high carbon steel.
6. Metallographic preparation and microstructure evaluation of different cast irons (grey cast iron, white cast iron, malleable cast iron, spheroidal graphite iron).
7. Metallographic preparation and microstructure evaluation of Copper.
8. Metallographic preparation and microstructure evaluation of Brass.
9. Determination of phase fraction and grain size using Image analyzer.
10. Drawing of the Binary phase diagrams of Isomorphous (Cu-Ni), Eutectic (Pb-Sn, Al-Si) and partial solubility diagram (Al-Cu) with interpretation.
11. Drawing of complex binary phase diagrams (Al_2O_3-SiO_2, MgO-Al_2O_3) and identification of points, lines and areas in them.
12. Experiments to obtain cooling curves for pure metals and alloys and to establish binary phase diagram.

Course Outcomes:

By completing this laboratory course, students:

1. Can describe the metallurgical microscope, sample preparation, mounting and use/choosing of different etching reagents.
2. Can identify and report the microstructural features of ferrous and non ferrous samples observed.
3. Can operate optical microscope with an ease.
4. Characterize microstructures of engineering alloys using optical microscopy and image analyzer.
5. Prepare formal laboratory reports.

IV-SEMESTER

TRANSPORT PHENOMENA

Subject Code: -	**BTMT401**	**IA Marks**	**40**
Number of Lecture Hours/Week:-	**04**	**Term End Exam Marks**	**60**
Total Number of Lecture Hours: -	**60**	**CREDITS**	**04**

Course Objectives:

1. This course will introduce the concepts of fluid flow, heat transfer and mass transfer with behavior and processing of engineering materials as the focus.
2. To learn Newton's law of viscosity, Navier-strokes equation, Darcy's law and their applications.
3. To study the methods of diffusion and their applications.

Module -1 (10 hours)

Balance of quantities using elemental volume approach, continuity equation Newton's law of viscosity.

Module -2 (10 hours)

Navier-Stokes equation, laminar flow problems, exact solutions in rectangular, cylindrical and spherical coordinate systems.

Module -3 (10 hours)

Friction factors, correlations for turbulent regime, Darcy's law, flow through porous media, Fundamentals of heat conduction, convection, radiation and their combined effect.

Module -4 (15 hours)

Steady and unsteady heat transfer, exact analytical solutions, correlations for conjugate heat transfer. Coupled phenomena in transport, non-dimensional numbers and their correlations of different regimes and analogies.

Module -5 (15 hours)

Diffusion and its application in solid state, convective mass transfer, unsteady diffusion in finite and infinite bodies, diffusion and chemical reactions.

Course Outcomes:

At the end of the course the student will be able to:

CO1. Demonstrate and understanding of heat transfer, fluid flow and mass transfer.
CO2. Pose a problem in transport phenomena as a balance equation.
CO3. Make suitable assumptions to make the problem a well-defined one.
CO4. Identify suitable geometry and boundary conditions for the problem.
CO5. Solve simple partial differential equations relevant to transport phenomena.
CO6. Plot different parameters and interpret the solutions.

Course Outcome No	Statement	Knowledge Level (KL)
CO1	Demonstrate and understanding of heat transfer, fluid flow and mass transfer.	K1
CO2	Pose a problem in transport phenomena as a balance equation.	K3
CO3	Make suitable assumptions to make the problem a well-defined one.	K1
CO4	Identify suitable geometry and boundary conditions for the problem.	K4
CO5	Solve simple partial differential equations relevant to transport phenomena.	K3
CO6	Plot different parameters and interpret the solutions.	K3

KL – Bloom's Knowledge Level (K_1, K_2, K_3, K_4, K_5, K_6)
K_1- Remember, K_2 – Understand, K_3 – Apply, K_4 – Analyze, K_5- Evaluate, K_6 – Create

Course Articulation Matrix: (Mapping of COs with POs & PSOs)

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3			3				2	1			
CO2	2				1		1	3	3			
CO3	3		2	3				1	1			
CO4												
CO5												
CO6												
CO Average	2.66		2	3	1		1	2	1.66			

3 - High; 2 - Medium; 1 – Low

Text Books:

1. Transport phenomena, 2nd Edition- R. Byron Bird, Warren E. Stewart and Edwin N. Lightfoot, published by John Wiley & Sons, 2006.
2. Fundamentals of Momentum, Heat and Mass Transfer, 5th Edition - Welty, Wicks Wilson, Rorrer published by John Wiley & Sons, 2008.

Reference Books:

1. Transport Phenomena in Materials Processing - D.R. Poirier and G.H. Geiger, published by John Wiley & Sons, 2010.
2. Introduction to Fluid Mechanics, 5th Edition – Alan T. McDonald, Fox, Robert W Fox, John Wiley & Sons, 2002.

METALLURGICAL THERMODYNAMICS-II

Subject Code: -	**BTMT402**	**IA Marks**	**40**
Number of Lecture Hours/Week:-	**04**	**Term End Exam Marks**	**60**
Total Number of Lecture Hours: -	**60**	**CREDITS**	**04**

Course Objectives:

This course is mainly intended to deals with

1. Interpret Ellingham diagrams
2. Identify metallurgical thermodynamics principles to be applied in phase diagrams.
3. Identify metallurgical thermodynamics principles to be applied in reversible cells

Module -1 (10 hours)

Ellingham Diagrams: Introduction, calculation of equilibrium constants from standard free energy changes, general description of Ellingham diagrams, Interpretation of free energy changes Vs. temperature lines, Richardson's diagrams.

Module -2 (10 hours)

Solutions: Solution definition, Composition, partial molal quantities, ideal solutions, Raoult's Law, actual (Nonideal) solutions, Sievert's law, Gibbs - Duhem equation, integration of Gibbs - Duhem equation, Excess thermodynamics quantities.

Module -3 (10 hours)

Application to phase diagrams: Concept of chemical potential, equality of chemical potentials in equilibrated phases, Derivation of Gibbs phase rule, solidus and liquidus lines for an ideal solution, calculation of liquidus line for eutectic systems.

Module -4 (15 hours)

Reversible Cells: Electro- Chemical cells, galvanic cells, chemical and electrical energy, thermodynamics of Electro-chemical cells, standard electrode potentials, sign convention of electrode potentials, application of Gibbs - Helmholtz equation to galvanic cells. Concentration Cells.

Module -5 (15 hours)

Kinetics: Kinetics of chemical process, Molecularity and order of a reaction, zero order reactions, first order, second order reactions, Determination of order of reaction, collision theory, theory of absolute reaction rates, consecutives and simultaneous reactions, catalysis in chemical reactions.

Text Books:

1. Physical Chemistry for Metallurgist by J. Mackowick, Allen and Unwin publisher, 1966.
2. Physical Chemistry of Metals by LS Darken and Gurry, CBS publisher and Distributor, 2002.

Reference Books:

1. Thermodynamics of solids by RA Swalin, Wiley VCH; 2nd edition, 1973.
2. Essentials of Metallurgical Thermodynamics – R.H. Tupkary, Khanna Book Publishing Co. (P) Ltd. 2016.
3. Principles of Metallurgical Thermodynamics: Subir Kumar Bose, Sanat Kumar Roy, Universities Press, 2014.

Course Outcomes:

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

CO1. Interpret Ellingham Diagram for oxides.
CO2. Knowledge of ideal and regular solutions and free energy of mixing.
CO3. Apply the phase rule on the metallurgical systems.
CO4. Understanding of the nature of polarized electrochemical reactions and an introduction of their application in corrosion behavior of metals.
CO5. Determine order of reaction. Explain the central concepts of chemical kinetics. Formulate and solve rate equations for various reactions.

Course Outcome No	Statement	Knowledge Level (KL)
CO1	Interpret Ellingham Diagram for oxides.	K1
CO2	Knowledge of ideal and regular solutions and free energy of mixing.	K3
CO3	Apply the phase rule on the metallurgical systems.	K6
CO4	Understanding of the nature of polarized electrochemical reactions and an introduction of their application in corrosion behavior of metals.	K4
CO5	Determine order of reaction. Explain the central concepts of chemical kinetics. Formulateand solve rate equations for various reactions	K2

KL – Bloom's Knowledge Level (K_1, K_2, K_3, K_4, K_5, K_6)
K_1- Remember, K_2 – Understand, K_3 – Apply, K_4 – Analyze, K_5- Evaluate, K_6 – Create

Course Articulation Matrix: (Mapping of COs with POs & PSOs)

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3			3				2	1			
CO2	2				1		1	3	3			
CO3	3		2	3				1	1			
CO4												
CO5												
CO Average	2.66		2	3	1		1	2	1.66			

3- High; 2- Medium; 1 –Low

NON- FERROUS PROCESS METALLURGY

Subject Code: -	**BTMT403**	**IA Marks**	**40**
Number of Lecture Hours/Week:-	**03**	**Term End Exam Marks**	**60**
Total Number of Lecture Hours: -	**45**	**CREDITS**	**03**

Course Objectives:

1. Understanding the Fundamentals of Non-Ferrous Metallurgy
2. Mastering the Principles of Mineral Benefication and Extraction
3. Gaining Expertise in Non-Ferrous Alloy Production and Processing
4. Understanding the Structure and Properties of Non-Ferrous Metals and Alloys
5. Applying Metallurgical Principles to Problem Solving and Material Selection.

Criteria	Description	Maximum Marks
Internal Assessment (IA)	Internal Examination	30
	Attendance/Discipline	5
	Assignment/ Seminar	5
Terminal Examination (TE)	Terminal Examination	60
Total		100
Attendance	A minimum of 75% Attendance is required to be maintained by a student to be qualified for taking up the End Semester examination. The allowance of 25% includes all types of leaves including medical leaves.	

Module -1 (10 hours)

Sources of nonferrous metals (Sources in land and sea, exploration methods, methods of beneficiation, nonferrous metals wealth in India), Principles of metals extraction, (Thermodynamic principles, homogeneous and heterogeneous reactions, Ellingham diagrams, kinetic principles, electro-chemistry).

Module -2 (10 hours)

General methods of extraction, (Pyro-metallurgy – calcinations, roasting (predominance area diagram) and smelting, Hydrometallurgy – leaching, solvent extraction, ion exchange, precipitation, and electrometallurgy – electrolysis and electro-refining)

Module -3 (10 hours)

General methods of refining, (Basic approaches, preparation of pure compounds, purification of crude metal produced in bulk), Extraction of metals from oxide sources, (Basic approaches and special features of specific extraction processes, extraction of metals such as Mg, Al, Sn),

Module -4 (10 hours)

Extraction of metals from sulphide ores, (Pyro-metallurgy and hydro-metallurgy of sulphides, production of metals such as copper, lead, zinc, nickel etc.), Extraction of metals from halides, (Production of halides and refining methods, production of reactive and reactor metals. Methods of extraction of metals such as Ti, Ur)

Module -5 (05 hours)

Production of precious metals (Methods applied for gold, silver and Pt.),

Course Outcomes:

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

CO1. Understanding the extraction and purification of non-ferrous metals
CO2. Knowledge of different processing techniques for various non-ferrous metals and alloys
CO3. Understanding the properties and applications of different non-ferrous materials
CO4. Ability to apply metallurgical principles to solve problems in the non-ferrous metals industry.

Course Outcome No	Statement	Knowledge Level (K)
CO1	understanding the extraction and purification of non-ferrous metals	K_1
CO2	knowledge of different processing techniques for various non-ferrous metals and alloys	K_3
CO3	understanding the properties and applications of different non-ferrous materials	K_6
CO4	Ability to apply metallurgical principles to solve problems in the non-ferrous metals industry.	K_4

KL – Bloom's Knowledge Level (K_1, K_2, K_3, K_4, K_5, K_6)
K_1- Remember, K_2 – Understand, K_3 – Apply, K_4 – Analyze, K_5- Evaluate, K_6 – Create

Course Articulation Matrix: (Mapping of COs with POs & PSOs)

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3			3				2	1			
CO2	2				1		1	3	3			
CO3	3		2	3				1	1			
CO4												
CO Average	2.66		2	3	1		1	2	1.66			

3 - High; 2 - Medium; 1 – Low

TEXT BOOKS:

1. Extraction of nonferrous metals, H.S. Ray, R.Sridhar and K.P. Abraham Affiliated East West Press Pvt Ltd., New Delhi (2007).
2. H.S. Ray and A. Ghosh, Principles of extractive metallurgy,Wiley Eastern Ltd., New Delhi (1991)

REFERENCE BOOKS:

1. W.H. Dennis, Extractive Metallurgy, Philosophical Library,New York (1965)
2. F. Habashi, Principles of Extractive Metallurgy, Vol.1, Gordon and Breach, New York (1969).
3. T. Rosenqvist, Principles of Extractive Metallurgy, McGraw Hill, New York (1983).
4. J.L. Bray, Nonferrous production metallurgy, Wiley, NewYork(1954).

METAL CASTING

Subject Code: -	**BTMT404**	**IA Marks**	**40**
Number of Lecture Hours/Week:-	**03**	**Term End Exam Marks**	**60**
Total Number of Lecture Hours: -	**45**	**CREDITS**	**03**

Course Objectives:

This course is mainly intended to

1. Introduce and explain various moulding, casting techniques and equipment used.
2. Principles of Solidification of casting, defects in castings and their remedies are also dealt in detail.

Module – 1 (10 hours)

Introduction to Foundry, Types of foundries - Steps involved in casting. Pattern types, allowances for pattern, pattern materials.

Moulding methods and processes - materials, equipment, Moulding sand ingredients, sand preparation and control, testing, cores and core making - its types.

Module – 2 (05 hours)

Sand castings - Green and dry, pressure die casting, Gravity die casting, permanent mould casting, centrifugal casting, precision investment casting, shell Moulding, CO_2 Moulding. Continuous casting and squeeze casting.

Module -3 (10 hours)

Purpose of the gating system, Components of gating system and its functions, Types of Risers and Runners. Design of gating system, Types of gates, Gating ratio and its functions, Gating systems and their characteristics.

Module – 4 (10 hours)

Solidification time and Chvorinov's rule, concept of progressive and directional solidifications, Metallurgical aspects of Casting. Types of Melting furnaces- crucibles, oil fired furnaces, electric furnaces and cupola, calculation of cupola charges, Degasification, inoculation, pouring techniques.

Module – 5 (10 hours)

Gray Cast iron- effect of chemical composition, carbon equivalent, and effect of alloying. Production of gray Cast Iron, ductile iron and malleable iron castings. Melting of Aluminium and Copper alloys. Casting defects arising due to moulding, coring, melting and pouring practice.

Course Outcomes:

At the end of the course the student will be able to:

CO1. Have fundamental knowledge of possibilities of using castings in different practical applications from their design and material point of view.

CO2. Understand different types of pattern, core and mould making processes.

CO3. Have basic knowledge of casting and its gating system.

CO4. Evaluate the effect of chemical composition of grey cast iron and casting defects.

Course Outcome No	Statement	Knowledge Level (KL)
CO1	Have fundamental knowledge of possibilities of using castings in different practical applications from their design and material point of view.	K1
CO2	Understand different types of pattern, core and mould making processes.	K3
CO3	Have basic knowledge of casting and its gating system.	K1
CO4	Evaluate the effect of chemical composition of grey cast iron and casting defects.	K4

KL – Bloom's Knowledge Level (K_1, K_2, K_3, K_4, K_5, K_6)
K_1- Remember, K_2 – Understand, K_3 – Apply, K_4 – Analyze, K_5- Evaluate, K_6 – Create

Course Articulation Matrix: (Mapping of COs with POs & PSOs)

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3			3				2	1			
CO2	2				1		1	3	3			
CO3	3		2	3				1	1			
CO4												
CO Average	2.66		2	3	1		1	2	1.66			

3- High; 2- Medium; 1– Low

Text Books:

1. Principles of Metal Casting - Heine, Loper and Rosenthal, Tata Mc Graw Hill Publishing Co, Ltd; New Delhi, 1995.
2. Foundry Technology - Peter Beeley, Elsevier Science Publisher, 2001

Reference Books:

1. Foundry Technology - Dharmendra Kumar / S.K.Jain, CBS Publisher, 2007.
2. Metal Casting: Principles and Practice, 1st edition by T.V. Ramana Rao, Newagepublishers,1996,
3. Principles of Foundry Technology, 5th edition by P. L. Jain, published by McGraw Hill Education, 2017

MECHANICAL METALLURGY

Subject Code: -	**BTMT405**	**IA Marks**	**40**
Number of Lecture Hours/Week:-	**03**	**Term End Exam Marks**	**60**
Total Number of Lecture Hours: -	**45**	**CREDITS**	**03**

Course Objectives:

1. To gain an understanding of the response of various metals under the application of stress and/or temperature.
2. To build necessary theoretical back ground of the role of lattice defects in governing both elastic and plastic properties of metals will be discussed.
3. Obtain a working knowledge of various hardness testing machines BHN, VHN, RHN.
4. Obtain a working knowledge of creep and fatigue and analysis of data.

Module -1 (10 hours)

Metallurgical fundamentals: Defects in crystalline materials – Point defects and line defects. The concept of dislocations, edge dislocation and screw dislocation. Slip and twinning. Interaction between dislocations, sessile dislocation, glissile dislocation, energy of a dislocation, dislocation climb, Jogs, forces on dislocations. Frank Reed source, Critical resolved shear stress.

Module -2 (10 hours)

Hardness Test: Brinell, Vickers, Rockwell, Microhardness test, relationship between hardness and other mechanical properties, Nanoindentation.

The Tension Test: Engineering stress-strain and True stress-strain curve. Tensile properties, conditions for necking, effect of temperature and strain rate on tensile properties.

Elastic and in-elastic action and properties in compression test.

The Impact Test: Notched bar impact test and its significance, Charpy and Izod Tests, fracture toughness testing - COD and CTOD tests, significance of transition temperature curve, metallurgical factors affecting on transition temperature, temper embrittlement.

Module -3 (05 hours)

Fracture: Elementary theories of fracture, Griffith's theory of brittle fracture, ductile fracture, notch sensitivity. Strain-Energy release rate, Stress Intensity Factor, Fracture Toughness and design, K_{IC} Plane-Strain Toughness testing, plasticity corrections, J-Integral.

Module -4 (10 hours)

Fatigue Test: Introduction, Stress cycles, S-N Curve, mechanism of fatigue failure, effect of mean stress, stress concentration, size, surface condition and environments on fatigue. Effect of metallurgical variables on fatigue. Low-cycle fatigue. High-cycle fatigue and thermal fatigue.

Module -5 (10 hours)

Creep and Stress Rupture: Introduction, The creep curve, Stress-rupture test, structural changes during creep, mechanism of creep deformation, theories of creep. Fracture at elevated temperature, effect of metallurgical variables on creep.

Course Outcomes:

At the end of the course the student will be able to:

CO1. : Interpret the effect of crystalline defects on the behavior of metals.

CO2. : Can conduct hardness, Impact test and interpret COD, CTOD and DBTT diagrams.

CO3. : Determine the appropriate test for analysis of tensile and compression properties of materials.

CO4. : Can design creep and fatigue resistant materials.

CO5. : Assess and describe the mechanism leading failure of a given material.

CO6. : Solve numerical problems and gain of knowledge of how to incorporate material strength limitation into engineering design.

Course Outcome No	Statement	Knowledge Level (KL)
CO1	Interpret the effect of crystalline defects on the behavior of metals.	K1
CO2	Can conduct hardness, Impact test and interpret COD, CTOD and DBTT diagrams.	K3
CO3	Determine the appropriate test for analysis of tensile and compression properties ofmaterials.	K1
CO4	Can design creep and fatigue resistant materials.	K4
CO5	Assess and describe the mechanism leading failure of a given material.	K3
CO6	Solve numerical problems and gain of knowledge of how to incorporate material strength limitation into engineering design.	K3

KL – Bloom's Knowledge Level (K_1, K_2, K_3, K_4, K_5, K_6)
K_1- Remember, K_2 – Understand, K_3 – Apply, K_4 – Analyze, K_5- Evaluate, K_6 – Create

Course Articulation Matrix: (Mapping of COs with POs & PSOs)

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3			3				2	1			
CO2	2				1		1	3	3			
CO3	3		2	3				1	1			
CO4												
CO5												
CO6												
CO Average	2.66		2	3	1		1	2	1.66			

3 -High; 2 - Medium; 1 – Low

Text Books:

1. Mechanical Metallurgy – G. E. Dieter, 3rd edition, published by McGraw Hill Education, 2017.
2. Mechanical behavior of material - Thomas H. Courtney, Published by Waveland Pr Inc, 2005.

Reference Books:

1. Engineering Materials Science – Cedric William Richards, published by Literary Licensing, LLC, 2012.
2. Mechanical behavior, 3rd Edition - Wayne Hayden, William G. Moffatt, John Wulff published by John wiley and Sons, Inc, 1974.
3. Mechanical Metallurgy – White & Lemay.

POWDER METALLURGY

Subject Code: -	**BTMT406**	**IA Marks**	**40**
Number of Lecture Hours/Week:-	**04**	**Term End Exam Marks**	**60**
Total Number of Lecture Hours: -	**60**	**CREDITS**	**04**

Course Objectives:

1. To build the necessary back ground of emergence and importance of powder metallurgy scope and limitations.
2. Obtain a necessary knowledge about various powder production techniques and characteristics.
3. Obtain a working knowledge of compaction and sintering techniques.
4. Gain an effective knowledge of applications of powder metallurgy products.

Module –1 (10 hours)

Introduction: Emergence and importance of powder metallurgy**:** Comparison of powder metallurgy with other fabrication techniques, its scope and limitations. Powder Production Methods: Physical, Chemical and Mechanical.

Module –2 (15 hours)

General Characterization of powders**:** Chemical composition, Particle size, Particle shape, Surface area, Apparent density, Tap density, Flow rate, green density, Green strength, Compressibility and Compact ability of powders.

Module –3 (10 hours)

Compaction**:** Classification and theory of consolidation. Die compaction. Cold and hot isostatic pressing, Powder rolling or roll compaction.

Module –4 (10 hours)

Sintering: Mechanisms of Sintering, activated sintering, Liquid phase sintering, Factors affecting sintering, Sintering atmospheres, Properties of sintered parts.

Module –5 (15 hours)

Applications**:** Porous parts**:** Self-lubricating bearings, filters: Dispersion strengthened alloys by powder metallurgy route**:** Cu / Al_2O_3, Sintered Aluminum Powder. Electrical materials**:** Tungsten lamp filaments. Magnetic materials**:** Soft magnetic materials (Fe, Fe-Ni); Permanent magnets (Alnico, $SmCo_5$), Cemented carbides and Cermets.

Course Outcomes:

At the end of the course the student will be able to:

CO1. Appreciate the importance of powder metallurgy technology for production of materials and components in comparison with other fabrication techniques.

CO2. List out the advantages, limitations and applications of powder metallurgy technique.

CO3. Able to choose the production method to get the required size and shape of the powders.

CO4. Knowledge of various characterization methods to control the properties of the powders.

CO5. Describe the consolidation and sintering processes in powder metallurgy route.

CO6. Can develop and design powder metallurgical components for specific applications and needs of various industries.

Course Outcome No	Statement	Knowledge Level (KL)
CO1	Appreciate the importance of powder metallurgy technology for production of materials and components in comparison with other fabrication techniques.	K1
CO2	List out the advantages, limitations and applications of powder metallurgy technique.	K3
CO3	Able to choose the production method to get the required size and shape of the powders.	K6
CO4	Knowledge of various characterization methods to control the properties of the powders.	K4
CO5	Describe the consolidation and sintering processes in powder metallurgy route.	K2
CO6	Can develop and design powder metallurgical components for specific applications andneeds of various industries.	K3

KL – Bloom's Knowledge Level (K_1, K_2, K_3, K_4, K_5, K_6)

K_1- Remember, K_2 – Understand, K_3 – Apply, K_4 – Analyze, K_5- Evaluate, K_6 – Create

Course Articulation Matrix: (Mapping of COs with POs & PSOs)

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3			3				2	1			
CO2	2				1		1	3	3			
CO3	3		2	3				1	1			
CO4												
CO5												
CO6												
CO Average	2.66		2	3	1		1	2	1.66			

3- High; 2- Medium; 1–Low

Text Books:

1. Powder Metallurgy, 2nd Edition - A.K. Sinha, Dhanpat Rai Publications, 2016.
2. Powder Metallurgy Technology - G S Upadhyaya, published by Cambridge International Science Publishing Ltd., 1998.

Reference Books:

1. Introduction to Powder Metallurgy, 1st Edition – J.S. Hirshhorn published by American Powder Metallurgy Institute, 1969.
2. Powder Metallurgy: Principles and Applications – Lenel, Fritz V, published by Metal Powder Industry, 1980.
3. Powder Metallurgy: Practice and Applications, 1st Edition – Sands, R. L. and C.R.

Shakespeare, published by George Newnes Limited, 1966.
4. Powder Metallurgy Science by Randall M. German, published by Metal Powder Industry, 1994.
5. Powder Metallurgy: Science, Technology and Applications, 2nd Edition – P.C. Angelo, R. Subramanian and B. Ravisankar, published by PHI Learning, 2022.

NON- FERROUS PROCESS METALLURGY LAB

Subject Code: -	**BTMT403P**	**IA Marks**	**40**
Number of Lecture Hours/Week:-	**02**	**Term End Exam Marks**	**60**
Total Number of Lecture Hours: -	**30**	**CREDITS**	**01**

Course Objectives

The course aims to:

1. Provide hands-on exposure to beneficiation, extraction, and refining techniques for non-ferrous metals.
2. Familiarize students with thermodynamic and kinetic principles in metallurgical operations through laboratory experiments.
3. Demonstrate pyrometallurgical, hydrometallurgical, and electrometallurgical processes on a laboratory scale.
4. Introduce analytical tools such as Ellingham and predominance area diagrams for predicting process feasibility.
5. Develop competency in handling, processing, and recovering metals from ores, concentrates, and solutions.

List of Laboratory Experiments

1. Study of Ore Beneficiation by Froth Flotation Method
2. Determination of Particle Size Distribution of Mined Ore by Sieving
3. Construction and Interpretation of Ellingham Diagram for Selected Metal Oxides
4. Demonstration of Predominance Area Diagram for Roasting of Sulphide Ores
5. Leaching Experiment for Extraction of Copper from Low-Grade Ore
6. Solvent Extraction of Aluminium from Leach Liquor
7. Electrowinning of Copper from Sulphate Solution
8. Electro-Refining of Copper
9. Smelting and Reduction of Metal Oxide (e.g., $SnO_2 \rightarrow Sn$)
10. Precipitation and Refining of Precious Metals (Demonstration for Silver Recovery from Solution).

Course Outcomes

After successful completion, students will be able to:

CO1. Apply ore beneficiation methods such as froth flotation and particle size analysis to improve ore quality.
CO2. Use thermodynamic tools like Ellingham diagrams to predict metal extraction feasibility.

CO3. Interpret predominance area diagrams to select suitable roasting or reduction conditions.
CO4. Perform hydrometallurgical operations such as leaching, solvent extraction, precipitation, and understand their controlling parameters.

METAL CASTING LAB

Subject Code: -	**BTMT504P**	**IA Marks**	**40**
Number of Lecture Hours/Week:-	**02**	**Term End Exam Marks**	**60**
Total Number of Lecture Hours: -	**30**	**CREDITS**	**01**

Course Objectives:

1. This lab course is designed to provide hands on experience on various foundry testing methods for evaluation of molding sand properties.

LIST OF EXPERIMENTS:

1. Preparation of gating system using green sand.
2. Study of particle size distribution of the sand.
3. Study of the variation of permeability of the green sand with clay and water.
4. Determination of the variation of sand properties like green hardness, green compact strength with additives in sands.
5. Determination of the variation of hot compact hardness and hot shear strength with additives in sands.
6. Determination of clay content in sand.
7. Determination of the shatter index of green sand.
8. Melting and casting of Aluminum alloys.
9. Melting and casting of Cast Iron.
10. Charge calculations of cast iron in a cupola.
11. Non-destructive testing of cast iron components.

Course Outcomes:

1. Broad knowledge about different types of pattern materials and designing of patterns.
2. Understand different methods of particle size measurement and properties measurements.
3. Determination of clay content present in the mould sand.
4. Understanding of different Nondestructive techniques for testing of materials.
5. Able to prepare patterns with sand.
6. Able to operate cupola furnace.

Course Objectives

The course aims to:

1. Provide students with hands-on knowledge of powder metallurgy processes from powder production to final product evaluation.
2. Familiarize students with powder characterization techniques and the influence of

powder properties on processing.

3. Demonstrate compaction and sintering processes along with their controlling parameters.
4. Correlate theoretical concepts of powder metallurgy with experimental data for process optimization.
5. Develop skills in analyzing the properties and performance of powder metallurgy products for various engineering applications.

List of Laboratory Experiments

1. **Study of Different Powder Production Methods** (Demonstration of atomization, electrolytic, reduction, and mechanical milling techniques with available samples)
2. **Measurement of Particle Size Distribution** (Using sieve analysis and/or laser diffraction methods)
3. **Determination of Particle Shape and Morphology** (Using optical microscopy or SEM image interpretation)
4. **Determination of Apparent Density and Tap Density** (Using Hall flowmeter and tap density apparatus)
5. **Measurement of Powder Flow Rate** (Using standard Hall flowmeter funnel)
6. **Determination of Green Density and Green Strength** (Preparing compacted specimens and evaluating mechanical strength)
7. **Study of Compressibility and Compactability of Metal Powders** (By varying compaction pressure and measuring density)
8. **Cold Compaction of Metal Powders** (Die compaction experiment and dimensional analysis of compacts)
9. **Sintering of Green Compacts** (Furnace sintering under different atmospheres and observation of dimensional changes)
10. **Study of Mechanical and Physical Properties of Sintered Products** (Hardness, porosity, microstructure analysis)

Course Outcomes

After completing the laboratory, students will be able to:

CO1. Identify and differentiate powder production methods based on physical, chemical, and mechanical principles.

CO2. Measure and analyze particle size distribution, shape, and morphology of powders.

CO3. Determine key powder characteristics such as apparent density, tap density, and flow rate.

CO4. Evaluate green density and green strength of compacted specimens and relate them to compaction parameters.

CO5. Demonstrate die compaction and understand the influence of compaction pressure on compact properties.

V- SEMESTER

BUSINESS ECONOMICS & FINANCIAL ANALYSIS

Subject Code: -	**BTMT501**	**IA Marks**	**40**
Number of Lecture Hours/Week:-	**03**	**Term End Exam Marks**	**60**
Total Number of Lecture Hours: -	**45**	**CREDITS**	**03**

Course Objective:

1. to prepare engineering students to analyze cost/ revenue/ financial data and to make economicand financial analysis in decision making process
2. to examine the performance of companies engaged in engineering.

Module - 1: (10 hours)

Macro-Economic Concepts: Economics- Micro & Macroeconomics-National Income Accounting - Methods of Estimation- Various Concepts of National Income - Inflation – Causes of Inflation and Measures to Control Inflation - New Economic Policy - Industrial policy, Trade policy, and Fiscal policy and its Impact on Industry-Types of companies-Features.

Module - 2: (05 hours)

Introduction to Business Economics- Basic Principles of Economics– Fundamental Concepts- Demand – Demand Determinants - Law of Demand- Demand Forecasting and Methods- Elasticity of Demand– Supply- Elasticity of Supply- Theory of Firm.

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Module - 3: (10 hours)

Production, Cost, Market Structures & Pricing:

Production Analysis: Factors of Production, Production Function, Production Function with one variable input, two variable inputs, Returns to Scale, Different Types of Production Functions. Cost analysis: Types of Costs, Short run and Long run Cost Functions. Market Structures: Nature of Competition, Features of Perfect competition, Monopoly, Oligopoly, and Monopolistic Competition. Pricing: Types of Pricing, Product Life Cycle based Pricing, Break Even Analysis, Cost Volume Profit Analysis (simple problems).

Module - 4: (10 hours)

Introduction to Accounting: Accounting Principles (GAPP), concepts, conventions- - Double entry system of Book keeping–Accounting rules- Journal- ledger- Trial balance- Trading and Profit and Loss account- Balance Sheet. (Simple Problems).

Module - 5: (10 hours)

Capital Budgeting Techniques: Significance of Capital Budgeting - cash flows-Time Value of Money- Choosing between alternative investment proposals- Methods of Appraisal Techniques- Pay Back Period - Average Rate of Return – Net Present Value- Internal Rate of Return – Profitability Index (simple problems).

Course Outcomes:

At the end of the course the student will be able to:

CO1. To perform and evaluate present and future worth of the alternate projects and to appraise projects by using traditional and DCF Methods.

CO2. To carry out cost benefit analysis of projects and to calculate BEP of different alternative projects.

Course Outcome No	Statement	Knowledge Level (KL)
CO1	To perform and evaluate present and future worth of the alternate projects and to appraise projects by using traditional and DCF Methods.	K1
CO2	To carry out cost benefit analysis of projects and to calculate BEP of different alternative projects.	K3

KL – Bloom's Knowledge Level (K_1, K_2, K_3, K_4, K_5, K_6)
K_1- Remember, K_2 – Understand, K_3 – Apply, K_4 – Analyze, K_5- Evaluate, K_6 – Create

Course Articulation Matrix: (Mapping of COs with POs & PSOs)

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3			3				2	1			
CO2	2				1		1	3	3			
CO Average	2.66		2	3	1		1	2	1.66			

3 - High; 2 - Medium; 1 – Low

Text Book/ Reference Book

1. Henry Malcom Steinar-Engineering Economics, Principles, McGraw Hill Pub.
2. D.D.Chaturvedi, S.L.Gupta, Business Economics - Theory and Applications, International Book House Pvt. Ltd. 2013.
3. Jain and Narang" Accounting, Kalyani Publishers.
4. Arora, M.N." Cost Accounting, Vikas Publication.
5. S.N.Maheshwari, Financial Management, Vikas Publishing House.

LIGHT METALS & ALLOYS

Subject Code: -	**BTMT502**	**IA Marks**	**40**
Number of Lecture Hours/Week:-	**04**	**Term End Exam Marks**	**60**
Total Number of Lecture Hours: -	**60**	**CREDITS**	**04**

Course Objectives:

This course is mainly intended:

1. To give an exposure of various alloy systems, phase diagrams and their applications.
2. To highlight the importance of alloy selection.

3. To demonstrate the influence of composition, processing and microstructural effect on properties of the nonferrous alloys.

Module -1 (15 hours)
Aluminium alloys: Classification, Properties and applications, Physical metallurgy of Al-Cu alloys, Al-Mg alloys, Al-Zn alloys, Al-Mn alloys, Al-Si alloys, Al-Li alloys, Ternary alloys, Al-Cu-Mg alloys, Al-Si-Mg alloys and Al-Zn-Mg alloys.

Module -2 (15 hours)
Magnesium Alloys: Classification, properties and applications, Alloying elements to magnesium and their purpose, Designation of magnesium alloys, Mg-Al-Zn alloys, Corrosion resistance of Mg-alloys.

Module -3 (10 hours)
Zinc Alloys: Classification, Properties and applications. Alloying elements to zinc and their purpose. Designation of Zinc alloys.

Module -4 (10 hours)
Titanium alloys: Classification, properties and applications, Ti-6Al-4V, Ti-8Al-1Mo-1V, Ti-13V-11Cr-3Al alloys. Titanium alloys for aerospace and aero engine applications.

Module -5 (10 hours)
Beryllium alloys: Classification properties and applications, Al-Be alloys, Corrosion resistance of Beryllium alloys.

Course Outcomes:

At the end of the course the student will be able to:

CO1. Able to classify Aluminum alloys and understand the importance of structure - property correlation in binary and ternary alloys.

CO2. Knowledge of Magnesium and Zinc alloys and their applications.

CO3. List out the properties of Titanium and its alloys and comprehend their usage.

CO4. Analyze the importance of properties and applications of Beryllium alloys.

CO5. Can develop and design stronger and safer new light weight alloys with the knowledge of metal properties for specialized applications with minimum consumption of materials.

Course Outcome No	Statement	Knowledge Level (KL)
CO1	Able to classify Aluminum alloys and understand the importance of structure - propertycorrelation in binary and ternary alloys.	K1
CO2	Knowledge of Magnesium and Zinc alloys and their applications.	K3
CO3	List out the properties of Titanium and its alloys and comprehend their usage.	K1
CO4	Analyze the importance of properties and applications of Beryllium alloys.	K4

CO5	Can develop and design stronger and safer new light weight alloys with the knowledge of metal properties for specialized applications with minimum consumption of materials.	K3

KL – Bloom's Knowledge Level (K_1, K_2, K_3, K_4, K_5, K_6)
K_1- Remember, K_2 – Understand, K_3 – Apply, K_4 – Analyze, K_5- Evaluate, K_6 – Create

Course Articulation Matrix: (Mapping of COs with POs & PSOs)

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3			3				2	1			
CO2	2				1		1	3	3			
CO3												
CO4												
CO5												
CO Average	2.5			3	1		1	2.5	2			

3 - High; 2 - Medium; 1 – Low

Text Books:

1. Light alloys: Metallurgy of the Light Metals, 5th Edition - Ian Polmear, David St.John, Jian-Feng Nie, Ma Qian published by Butterworth-Heinemann, 2017.
2. Introduction to Physical Metallurgy, 2nd Edition – Sidney H. Avner, published by McGraw Hill Education, 2017

Reference Books:

1. Heat Treatment, structure and properties of Nonferrous Alloys - Charlie R. Brooks, Published by ASM International, 1982.
2. Engineering Physical Metallurgy, 1st Edition – Lakhtin published by CBS Publishers and Distributors Pvt. Ltd., 2005.
3. ASM Metals Handbook Vol-1 & 2, 1990.
4. Metallurgical Abstracts on Light Metals and Alloys, Volume – 32 - Keikinzoku Shōgakukai, published by Light Metal Educational Foundation, 1999.

HEAT TREATMENT AND PHASE TRANSFORMATIONS

Subject Code: -	**BTMT503**	**IA Marks**	**40**
Number of Lecture Hours/Week:-	**04**	**Term End Exam Marks**	**60**
Total Number of Lecture Hours: -	**60**	**CREDITS**	**04**

Pre-Requisites: Physical Metallurgy

Course Objectives:

1. This course is mainly designed to impart knowledge about basic principles and process variables of different heat treatment processes.
2. Thermo mechanical treatment, Surface hardening techniques, heat treatment of steels, cast

irons, nonferrous alloys will also be dealt in detail.

3. Identification of heat treatment defects and related knowledge of heat treatment furnaces will also be dealt in detail.

Module -1 (15 hours)

Principles of Heat Treatment of steels, Formation of Austenite on heating, Austenitic grain size, determination and decomposition of austenite. TTT and CCT curves. Effect of alloying elements on TTT curves and Fe-Fe3C diagram. Phase Transformations: Pearlitic Transformation, Bainitic Transformation, Martensitic Transformation, Order-disorder transformation, Spinodal decomposition.

Module -2 (15 hours)

Annealing, Normalizing, Hardening and tempering. Mechanism of heat removal during quenching, quenching media, size effect and mass effect. Tempering and its stages, Austempering, Martempering, Subzero treatment, Patenting. Hardenability of steels, Factors affecting and its determination.

Module -3 (10 hours)

Surface Hardening: Principles and Applications of Carburizing, Nitriding, Carbonitriding, Nitrocarburizing, Boronizing and Aluminizing; Flame, Induction and Laser surface hardening.

Module –4 (10 hours)

Thermo-mechanical treatments: HTMT, LTMT, Ausforming, Isoforming, Cryoforming.Heat-Treatment of Cast Irons.

Module -5 (10 hours)

Heat-Treatment of Copper and its alloys and Aluminium and its alloys.

Heat treatment furnaces, types and applications, Atmospheres, Heat treatment defects and remedies.

Course Outcomes:

At the end of the course the student will be able to:

CO1. Apply and interpret phase and continuous cooling diagrams information to assess the impact of a range of heat treatment procedures.

CO2. Demonstrate a critical understanding of the importance of heat treatment in achieving it for purpose in metals and alloys.

CO3. Learn the fundamentals of microstructure modifications through thermo mechanical and surface heat treatment processes to achieve the desired properties.

CO4. Propose suitable heat treatment procedures for non ferrous metals like Cu, Al etc.

CO5. Identify and give reasons for the heat treatment defects and explain the various heat treatment furnaces and atmospheres.

CO6. Correlate the microstructure properties, processing and performance of alloys

Course Outcome No	Statement	Knowledge Level (KL)
CO1	Apply and interpret phase and continuous cooling diagrams information to assess the impact of a range of heat treatment procedures.	K1
CO2	Demonstrate a critical understanding of the importance of heat treatment in achieving it forpurpose in metals and alloys.	K3
CO3	Learn the fundamentals of microstructure modifications through thermo mechanical andsurface heat treatment processes to achieve the desired properties.	K1
CO4	Propose suitable heat treatment procedures for non ferrous metals like Cu, Al etc.	K4
CO5	Identify and give reasons for the heat treatment defects and explain the various heattreatment furnaces and atmospheres.	K3
CO6	Correlate the microstructure properties, processing and performance of alloys	K3

KL – Bloom's Knowledge Level (K_1, K_2, K_3, K_4, K_5, K_6)
K_1- Remember, K_2 – Understand, K_3 – Apply, K_4 – Analyze, K_5- Evaluate, K_6 – Create

Course Articulation Matrix: (Mapping of COs with POs & PSOs)

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3			3				2	1			
CO2	2				1		1	3	3			
CO3	3		2	3				1	1			
CO4												
CO5												
CO6												
CO Average	2.66		2	3	1		1	2	1.66			

3 -High; 2 -Medium; 1 –Low

Text Books:

1. Heat Treatment Principle and Techniques, 2nd edition – T.V. Rajan, C.P. Sharma, Ashok Sharma, 2011.
2. Phase Transformations in Metals and Alloys, 4th edition - David A. Porter, Kenneth E. Easterling, and Mohamed Y. Sherif, CRC Press, Taylor & Francis Group, 2021

Reference Books:

1. Heat Treatment of Metals - Vijendra Singh, Standard Publishers Distributors, 2020.
2. Engineering Physical Metallurgy –Y. Lakhtin, CBS Publishers & Distributors, 2009.
3. Physical Metallurgy for Engineers - R. Varney Wilbur Donald S. Clark, published by Affiliated East-West Press (Pvt.) Ltd, 2018.
4. Physical Metallurgy Principles - Robert E. Reed-Hill, published by Affiliated East-West Press, 2008.

METAL FORMING & METAL JOINING

Subject Code: -	**BTMT504**	**IA Marks**	**40**
Number of Lecture Hours/Week:-	**03**	**Term End Exam Marks**	**60**
Total Number of Lecture Hours: -	**45**	**CREDITS**	**03**

Course Objective:

1. Gain an understanding of fundamentals of metal working.
2. Analyze the behavior of metals during plastic deformation.
3. Obtain a working knowledge of forging, rolling, extrusion, and wiredrawing.

Module -1 (10 hours)

FUNDAMENTALS OF METAL WORKING: Classification of forming processes, Mechanics of metal working for slab method and uniform deformation energy method. Cold working, Recovery, Recrystallization and grain growth, hot working, Strain-Rate effects, Work of plastic deformation.

Module – 2 (10 hours)

FORGING: Classification of forging processes, forging equipment. Forging in plane strain. Open-die forging, closed-die forging, Forging of a cylinder in plane-strain. Forging defects, powder metallurgy forging. ROLLING OF METALS**:** Classification of rolling processes, rolling mills. Hot rolling, cold rolling, rolling of bars and shapes, forging and geometrical relationships in rolling. Simplified analysis of rolling load, rolling variables, problems and defects in rolled products. Theories of hot rolling, torque and horsepower, theories of cold rolling, torque and horsepower.

Module -3 (10 hours)

Basic Science of Welding Processes. Sources of heat energy, the flame, the electric arc. Chemical reactions during welding, oxidation reaction, protection of weld pool with fluxes or gases. Microstructural changes during welding, the effect of heat on metals. Pre-treatment and post-treatment of welds.

Module -4 (05 hours)

Gas and Arc Welding processes: Classification of welding processes- fusion welding processes, oxy-acetylene welding, arc welding-manual, submerged arc welding, gas tungsten arc and gas metal arc welding; practice, joint design and preparation and their advantages and disadvantages

Module -5 (10 hours)

Resistance and Pressure Welding processes: Pressure welding- Cold and hot pressure welding, friction and friction stir welding, and diffusion welding. Resistance welding- spot and projection welding; practice, joint design and preparation and their advantages and disadvantages.

Text Books:

1. Mechanical Metallurgy, 3rd Edition - by George E. Dieter, Published by McGraw Hill Education, 2017.
2. Engineering Metallurgy (Part-II) – Raymond Aurelius Higgins, Published by English Universities Press, 1960
3. Welding Processes and Technology, 3rd Edition, - Dr. R.S. Parmar, Khanna Publishers, 2013.
4. Modern Welding Technology, 4th edition - Howard B. Cary, Published by Prentice Hall, New Jersey, USA, 1997.

Reference Books:

1. Fundamentals of Metal Forming Processes, 2nd Edition – B.L. Juneja, New age International Publishers, 2018.
2. Technology of Metal Forming Processes – Surender Kumar, PHI publication, 2008.
3. Handbook of Metal Forming Process - Darren Wang, published by NY Research Press, 2015.

Course Outcomes:

At the end of the course the student will be able to:

CO1. Know the basic science of welding processes and list out their types and the principles guiding the operations. Appreciate the effect of welding parameters on the structure and mechanical properties of welded parts.

CO2. Identify different energy sources like electron beam, laser beam, plasma arc, explosion welding, ultrasonic welding etc and analyze the concept, mechanism, parameters associated with the processes.

CO3. Demonstrate weld design procedures and also describe soldering and brazing techniques convincingly.

CO4. Categorize different welding techniques for metals, alloys, non metals, dissimilar metals etc.,

CO5. Understand the causes of welding defects and how they can be prevented.

CO6. Selectively select a process for a specific application/ need/situation depending upon the availability of sources.

Course Outcome No	Statement	Knowledge Level (KL)
CO1	Know the basic science of welding processes and list out their types and the principles guiding the operations. Appreciate the effect of welding parameters on the structure and mechanical properties of welded parts.	K1
CO2	Identify different energy sources like electron beam, laser beam, plasma arc, explosion welding, ultrasonic welding etc and analyze the concept, mechanism, parameters associatedwith the processes.	K3
CO3	Demonstrate weld design procedures and also describe soldering and brazing techniques convincingly.	K1

CO4	Categorize different welding techniques for metals, alloys, non metals, dissimilar metals etc.,	K4
CO5	Understand the causes of welding defects and how they can be prevented.	K3
CO6	Selectively select a process for a specific application/ need/situation depending upon the availability of sources.	K2

KL – Bloom's Knowledge Level (K_1, K_2, K_3, K_4, K_5, K_6)
K_1- Remember, K_2 – Understand, K_3 – Apply, K_4 – Analyze, K_5- Evaluate, K_6 – Create

Course Articulation Matrix: (Mapping of COs with POs & PSOs)

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3			3				2	1			
CO2	2				1		1	3	3			
CO3	3		2	3				1	1			
CO4												
CO5												
CO6												
CO Average	2.66		2	3	1		1	2	1.66			

3- High; 2-Medium; 1–Low

IRON AND STEEL MAKING

Subject Code: -	**BTMT505**	**IA Marks**	**40**
Number of Lecture Hours/Week:-	**03**	**Term End Exam Marks**	**60**
Total Number of Lecture Hours: -	**45**	**CREDITS**	**03**

Course Objectives:

1. Discuss the evolution of Iron making in chronological order.
2. Illustrate the applications of thermodynamics and kinetics in production of pig iron and refining it.
3. Outline the techniques for production and primary processing in Blast furnace.
4. Differentiate between past and present production methods and examine the modern trends in iron production.
5. Identify consists and effect for blast furnace irregularities and their remedial measures.
6. Discuss the evolution of steel making processes in chronological order.
7. Illustrate the applications of thermodynamics and kinetics in production of steel making.
8. Outline the techniques for production and primary processing in steel making.
9. Explain the casting processes for steel.

Module – 1 (10 hours)

Raw materials for Iron making. Occurrence and distribution of iron ores. Classification and factors affecting valuation of iron ores. Preparation of iron ores. Blast Furnace profile and design considerations. Furnace lining. Furnace cooling system.BF Stoves. BF gas cleaning system. Blast furnace operation and irregularities.

Module – 2 (15 hours)

Systems of importance in iron making, blast furnace reactions. Thermodynamics of iron oxide reduction by CO + CO_2 and H_2 and H_2O mixtures. Control of C, Si, S, P in metals and slags. Modern trends in blast furnace: High top pressure, humidification of blast, Oxygen enrichment,hot blast temperature and top charging systems.

Module – 3 (10 hours)

Alternative routes of iron making: Sponge iron making: HYL and Rotary Kiln.
Smelting and reduction methods such as Corex process.

Module – 4 (10 hours)

Classification of Steel making Processes. Raw materials for steel making. Factors affecting the efficiency of steel making. Principles of Steel Making - Decarburisation, Desiliconization. Dephosphorisation and Desulphurization. Deoxidation practice. Molecular and ionic theory ofslags.

Module – 5 (15 hours)

Bessemer and open-hearth steel making processes, electric arc steel making. LD, LD - AC steel making processes. Bottom blown O_2 processes. Combined blow processes. Casting pit side practice, Teeming methods. Solidification of steels – killed steels, semi killedsteels and Rimming steels. Ingot defects and remedies. Secondary steel making processes - Vacuum treatment of steels**:** RH and DH process. Continuous casting of steels.

Text Book:

1. Iron Making and Steel Making – Theory and practice - Ahindra Ghosh and Amit Chatterjee published by Prentice Hall India Learning Pvt. Ltd, 2008.
2. An Introduction to Modern Steel Making, 7th Edition – Dr. R. H. Tupkary and V. R. Tupkary, Khanna Publishers, 2000.
3. Iron making and steel making – Theory and practice Ahindra and Ghosh.
4. Hot metal production by smelting reduction of Iron ore - Amit Chatterjee, P & H publications, 2010.
5. An Introduction to Modern Iron Making - Dr. R.H. Tupkary, Khanna Publishers, 2004.

Reference Books:

1. Steel Making - A.K. Chakrabarti, published by Prentice Hall India Learning Pvt. Ltd, 2006.
2. Steel Making - V.A. Kudrin, Mir Publishers, 1985.
3. Beyond the B.F – Amit Chatterjee.
4. Sponge Iron production by direct reduction of Iron ores - Amit Chatterjee, P & H, publications, 2010.

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

CO1. Describe the developments of Iron making and recognize the importance of processing raw materials for Iron making keeping in view of economics, safety and efficiency.

CO2. Identify the required parameters and design of a blast furnace and illustrate ancillary equipment and measures to be taken for starting and trouble shooting of Blast furnace process.

CO3. Predict the physico-chemical phenomena taking place in blast furnace. Able to perform simple mass balance and complex problems.

CO4. Identify and explain the modernization techniques to improve quantity, quality and minimization of waste.

CO5. Able to predict the possible alternative processes to be followed suitable to the local conditions in view of energy, environmental and efficiency considerations.

CO6. Able to undertake any technical assignment in R&D and production units with professional responsibility towards profession and society.

Course Outcome No	Statement	Knowledge Level (KL)
CO1	Describe the developments of Iron making and recognize the importance of processing raw materials for Iron making keeping in view of economics, safety and efficiency.	K1
CO2	Identify the required parameters and design of a blast furnace and illustrate ancillary equipment and measures to be taken for starting and trouble shooting of Blast furnace process.	K3
CO3	Predict the physico-chemical phenomena taking place in blast furnace. Able to perform simple mass balance and complex problems.	K6
CO4	Identify and explain the modernization techniques to improve quantity, quality andminimization of waste.	K4
CO5	Able to predict the possible alternative processes to be followed suitable to the local conditions in view of energy, environmental and efficiency considerations.	K2
CO6	Able to undertake any technical assignment in R&D and production units with professionalresponsibility towards profession and society.	K3

KL – Bloom's Knowledge Level (K_1, K_2, K_3, K_4, K_5, K_6)
K_1- Remember, K_2 – Understand, K_3 – Apply, K_4 – Analyze, K_5- Evaluate, K_6 – Create

Course Articulation Matrix: (Mapping of COs with POs & PSOs)

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3			3				2	1			
CO2	2				1		1	3	3			
CO3	3		2	3				1	1			
CO4												
CO5												
CO6												
CO Average	2.66		2	3	1		1	2	1.66			

3 - High; 2 - Medium; 1 – Low

EMPLOYMENT ENHANCEMENT COURSE – I

Subject Code: -	**BTMT506**	**IA Marks**	**40**
Number of Lecture Hours/Week:-	**02**	**Term End Exam Marks**	**60**
Total Number of Lecture Hours: -	**30**	**CREDITS**	**01**

Course objectives:

1. Employment Enhancement Course-I is aimed to developing key employability skills.
2. It develops the leadership, planning, and organizational skills.
3. The course aims to bridge the gap between skills possessed by individuals and those sought by employers.

Assessment plan:

Criteria	Description	Maximum Marks
Internal Assessment (IA)	Internal Examination	30
	Attendance/Discipline	5
	Assignment/ Seminar	5
Terminal Examination (TE)	Terminal Examination	60
Total		100
Attendance	A minimum of 75% Attendance is required to be maintained by a student to be qualified for taking up the End Semester examination. The allowance of 25% includes all types of leaves including medical leaves.	

Course Contents:

MODULE 1: EMPLOYABILITY SKILLS

Communication Skills: This module focuses on enhancing verbal and non-verbal communication, including effective listening, clear expression, and adapting communication styles.

Corporate Etiquette and Soft Skills: Students learn professional conduct, workplace manners, teamwork, and time management.

Resume Building and Interview Skills: This module equips students to craft resumes and develop confidence for interviews, including body language and mock interview practice.

MODULE 2: APTITUDE AND REASONING SKILLS

Analytical Skills: logical reasoning, quantitative aptitude, data interpretation, and problem-solving, which are frequently tested in job applications and interviews.

Reasoning Skills: Similar to analytical skills, this module focuses on developing critical thinking, pattern recognition, and deductive reasoning abilities,

MODULE 3: COMPUTER AND TECHNICAL SKILLS

Basic Computer Knowledge: This module often covers essential computer skills, including working with MS Office applications (like Word, Excel, and PowerPoint) and navigating the internet.

Technical Skill Building: Some programs may include modules offering basic technical skills relevant to the students' fields of study (e.g., programming, networking, content writing)

MODULE 4: DEVELOPING KEY TRAITS

Leadership and Management: Understanding different leadership styles, motivating teams, delegating tasks, and taking initiative.

Time Management: Prioritizing tasks, setting goals, managing time effectively, and meeting deadlines.

Adaptability: Adjusting to changing circumstances, embracing new challenges, and remaining flexible in the workplace.

Work Ethics: Understanding professional conduct, demonstrating responsibility, and maintaining a positive attitude.

MODULE 5: PRACTICAL APPLICATIONS AND CAREER PLANNING

Resume and Cover Letter Writing: Crafting compelling resumes and cover letters that highlight relevant skills and experience.

Interview Skills: Practicing interview techniques, preparing for different types of interviews, and effectively showcasing qualifications.

Networking: Building professional connections, attending industry events, and leveraging social media for career advancement.

Career Planning: Setting career goals, identifying career paths, and developing a plan for achieving career aspirations.

Course outcomes:

CO1. Upon completing the course, students are expected to possess improved communication skills.
CO2. It enhanced analytical and reasoning abilities.
CO3. It builds self-confidence, better teamwork skills.
CO4. It creates a stronger foundation for entering the workforce.

Course Outcome No	Statement	Knowledge Level (KL)
CO1	Upon completing the course, students are expected to possess improved communication skills.	K_1
CO2	It enhanced analytical and reasoning abilities.	K_2
CO3	It builds self-confidence, better teamwork skills.	K_3
CO4	It creates a stronger foundation for entering the workforce.	K_6

KL- Bloom's Knowledge Level (K_1, K_2, K_3, K_4, K_5, K_6)
K_1-Remember, K_2- Understand, K_3- Apply, K_4- Analyze, K_5- Evaluate, K_6- Create

Course Articulation Matrix: (Mapping of COs with POs & PSOs)

CO	CORRELATION WITH PROGRAM OUTCOMES												CORRELATION WITH PSOs	
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	3				2			2				1	1
CO2	1			2							1			
CO3	1	2												
CO4														
CO(Average)	1.3	2.5		2		2			2		1		1	1

3 –High; 2 –Medium; 1 –Low

HEAT TREATMENT AND PHASE TRANSFORMATIONS LAB

Subject Code: -	**BTMT503P**	**IA Marks**	**30**
Number of Lecture Hours/Week:-	**02**	**Term End Exam Marks**	**20**
Total Number of Lecture Hours: -	**30**	**CREDITS**	**01**

Pre-Requisites: Heat Treatment and Phase Transformations

Course Objectives:

This course is mainly designed to

1. To conduct various heat treatment processes, surface hardening techniques and age hardening processes on different materials.
2. Gain knowledge of phase transformations taking place under various conditions of heat treatment.

List of Experiments:

1. Annealing of plain carbon steel and observation of microstructure.
2. Normalizing of plain carbon steel and observation of microstructure.
3. Hardening of plain carbon steel with quenching in water and brine solution and observation of microstructures.
4. Hardening of plain carbon steel with quenching in oil and observation of microstructure.
5. Effect of tempering temperature on plain carbon steel.
6. Effect of tempering time on plain carbon steel.
7. Age hardening of Aluminium - Copper alloys.
8. Spheroidizing of a given high carbon steel.
9. Surface hardening of plain carbon steel.
10. Determination of hardenability of medium carbon steel by Jominy end quench test.
11. Determination of phase fraction and grain size using Image analyzer.

Course Outcomes:

At the end of the course the student will be able to:

1. Conduct heat treatment in furnaces under suitable/ required time, temperature and

atmospheric conditions.
2. Modify the microstructures of metals and alloys through heat treatment practice for obtaining desired properties in present and future.
3. To modify the surface properties of steels.
4. To determine hardenability by performing Jominy end quench test
5. Analyze, correlate and interpret the results obtained in the tests conducted.
6. Report the observations in a formal manner.

METAL FORMING AND METAL JOINING LAB

Subject Code: -	**BTMT504P**	**IA Marks**	**30**
Number of Lecture Hours/Week:-	**02**	**Term End Exam Marks**	**20**
Total Number of Lecture Hours: -	**30**	**CREDITS**	**01**

Course Objectives:

This lab course is designed to know

1. To know the behaviour of the materials under various types of loading.
2. Provide knowledge and experience in the measurement of various material properties.
3. To operate the various equipment like Erichson cupping, rolling mill etc.., and analyze the process in them.
4. It also designed to make the student to understand and demonstrate the various types of welding processes and its variables.
5. Understand and apply the principles of metal casting process and develop relation between input and output parameters.
6. To study the various modes of metal transfer that exists in welding processes.

LIST OF EXPERIMENTS:

1. Determination of forming limit diagram
2. Kinetics of static recrystallization in a cold worked metal.
3. Growing of single crystals by Strain annealing technique.
4. Verification of Hall-Petch relation.
5. The work hardening and strain rate sensitivity of a metal.
6. The effect of plastic anisotropy on the deformation behaviour.
7. Soldering
8. Arc welding of dissimilar metals
9. Microstructure study of HAZ
10. Testing of welded joints – Hardness survey and Tensile test
11. Microstructure study of welded joints
12. Inspection of welded joints by dye penetration, Magnetic methods and ultrasonic method.

Course Outcomes:

1. To know the behaviour of the materials under various types of loading.

2. Provide knowledge and experience in the measurement of various material properties.
3. Determine strain hardening exponent, effect of grain size and plastic anisotropy under various types of experiments/ practical conditions.
4. Determine the effect of process variables affecting various forming methods.
5. Work on forging, extrusion and rolling mills and analyze and interpret the outcome of the processes.
6. Prepare formal laboratory reports.

VI -SEMESTER

CERAMICS AND COMPOSITE MATERIALS

Subject Code: -	**BTMT601**	**IA Marks**	**40**
Number of Lecture Hours/Week:-	**04**	**Term End Exam Marks**	**60**
Total Number of Lecture Hours: -	**60**	**CREDITS**	**04**

Course Objectives:

1. Develop understanding of the structure of ceramic materials on multiple length scales.
2. Develop knowledge of point defect generation in ceramic materials, and their impact ontransport properties.
3. To describe key processing techniques for producing metal, ceramic and polymer-matrixcomposites.
4. To demonstrate the relationship among synthesis, processing, and properties in compositematerials

Module -1 (10 hours)

Introduction – classification of ceramics – imperfections in ceramics – structure of ceramics – crystal structures – oxide structures – silicate structures – glass formation – types of glasses.

Module -2 (10 hours)

Ceramic Phase diagrams: Study of binary phase diagrams like MgO-NiO; CaO-MgO;MgO-Al_2O_3, Al_2O_3 - SiO_2.

Module -3 (15 hours)

Introduction to Composite materials, Fibers: Fabrication, structures, properties and applications of glass fibers, boron fibers, carbon fibers, organic fibers, ceramic fibers and metallic fibers. Matrix materials: Polymers, metals and ceramic matrix materials.

Module -4 (15 hours)

Manufacturing of composites: polymer matrix composites, metal matrix composites, ceramic matrix composites, carbon fiber composites.

Module -5 (10 hours)

Interfaces and bonding, strengthening and toughening mechanism, Testing of interfacial strength.

Text Books:

1. Introduction to Ceramics by William David Kingery, John Wiley and Sons Ltd. publishers, 1976.
2. Composite Materials-science and Engineering, 2nd edition - Krishan K. Chawla, Springer (Sie) publishers, 2006.

Reference Books:

1. Engineering Materials and their applications, 4th edition - Richard A. Flinn, Paul K. Trojan, Wiley publishers, 1990.
2. Hand book of Fibre – reinforced composite materials – George Lubin, Springer publishers, 1982.

Course Outcomes:

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

CO1. Identify and explain the types of ceramic materials and their applications.
CO2. Illustrate and interpret the ceramic phase diagrams.
CO3. Identify and explain the types of composite materials and their characteristic features
CO4. Predict and list out the properties matrix and reinforcement materials
CO5. Describe fundamental fabrication processes for polymer matrix, metal matrix, and ceramic matrix composites.
CO6. Able to undertake any technical assignment in R&D and production of newer and smarter materials.

Course Outcome No	Statement	Knowledge Level (KL)
CO1	Identify and explain the types of ceramic materials and their applications.	K1
CO2	Illustrate and interpret the ceramic phase diagrams.	K3
CO3	Identify and explain the types of composite materials and their characteristic features	K6
CO4	Predict and list out the properties matrix and reinforcement materials	K4
CO5	Describe fundamental fabrication processes for polymer matrix, metal matrix, and ceramicmatrix composites.	K2
CO6	Able to undertake any technical assignment in R&D and production of newer and smartermaterials.	K4

KL – Bloom's Knowledge Level (K_1, K_2, K_3, K_4, K_5, K_6)
K_1- Remember, K_2 – Understand, K_3 – Apply, K_4 – Analyze, K_5- Evaluate, K_6 – Create

Course Articulation Matrix: (Mapping of COs with POs & PSOs)

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3			3				2	1			
CO2	2				1		1	3	3			
CO3	3		2	3				1	1			
CO4												
CO5												
CO6												
CO Average	2.66		2	3	1		1	2	1.66			

3 -High; 2 -Medium; 1 –Low

FUELS, FURNACES & REFRACTORIES

Subject Code: -	**BTMT602**	**IA Marks**	**40**
Number of Lecture Hours/Week:-	**04**	**Term End Exam Marks**	**60**
Total Number of Lecture Hours: -	**60**	**CREDITS**	**04**

Course Objectives:

1. Relate the properties and applications of solid, liquid and gaseous fuels.
2. Broad knowledge on modes of heat transfer.
3. Describe the different types of refractories and pyrometers and their properties and uses.
4. Have a basic knowledge on working of different types of furnaces.

Module –1 (10 hours)

Introduction to Fuels technology: Classification of fuels, Origin and classification of coal, Proximate and ultimate analysis of coal and its applications. Properties and uses of Pulverized coal, Carbonization of coal and types of Carbonization. Properties, uses and testing of Metallurgical Coke.

Liquid fuels: Properties and applications.

Module –2 (15 hours)

Manufacture, properties and uses of Producer gas and Water gas.

Modes of heat transfer, Importance of heat transfer. Steady State Heat Transfer: Conduction through plane, cylindrical, Spherical and compound walls. Convection: Free and Forced conventions. Heat transfer by combined effect of conduction and convection between two fluids separated by a plane wall and cylindrical wall.

Module -3 (10 hours)

Furnaces: Classification and uses of furnaces, characteristic features of Vertical Shaft furnaces, Reverberatory furnaces, Arc and Induction furnaces, Tube and Muffle type Resistance furnaces, Continuous furnaces. Heat losses in furnaces and heat balance.

Module -4 (10 hours)

Pyrometry: Thermo electric pyrometer - Peltier and Thomson e.m.f. Thermo-electric power of thermocouples. Required properties of thermocouples. Noble and base metal thermocouples. Principle, operation and applications of Thermometer, Optical and Radiation pyrometers.

Module – 5 (15 hours)

Refractories: Classification and desirable properties of refractories, modes of failure of refractories in service and their prevention. Manufacturing methods and properties of Fireclay, Silica, Magnesite, Dolomite, Chromite and Carbon refractories. Testing of Refractories, Applications of refractories in the metallurgical industries.

Text Books:

1. Fuels, Furnaces and Refractories – O.P. Gupta, 6th edition, Khanna Publishers, 1989.

2. Metallurgical furnaces – Krivadan and Markov, MIR publishers, 1980.

Reference Books:

1. Elements of fuel technology – HIMUS, TBS The Book Service Ltd; 2nd Revised edition 1958.
2. Furnaces - J. D. Gilchrist, Pergamon Pr; 2nd edition, 1977.
3. Pyrometry -W.P. wood & J. M. Corck.
4. Elements of heat transfer - Jakob & Hawikns, John Wiley & Sons, 3rd edition, 1957.
5. Elements of thermodynamics & heat transfer - Obert & Young, McGraw-Hill Inc., US, 3rd edition,1962.
6. Control systems & Instrumentation – S. Bhasker.

Course Outcomes:

At the end of the course the student will be able to:

CO1. Know about a fuel, classify them and compare different types of fuels and describe their testing methods. Explain the coke making process, list out the properties and its by-products recovery and suggest methods for decreasing environmental pollution and energy consumption.

CO2. Apply principles of heat and mass transfer to basic engineering systems and understand the basic concepts and laws of the three modes of heat transfer and apply analytical techniques to the solution of conduction heat-transfer problems.

CO3. Classify and explain construction and working of different furnaces. Analyze the causes of heat losses in furnaces and suggest methods of minimization of heat loss and waste heat recovery.

CO4. Describe the operation of a thermocouple. Describe various temperature-measuring devices

CO5. thermometers and pyrometers. Discuss the principles that govern noncontact thermal measurements and describe the operation of optical and radiation pyrometers.

CO6. Explain various manufacturing and testing processes of refractories. Itemize many examples of metallurgical refractories under different categories, their main properties and applications. Link inherent properties of the refractory mineral and how it affects the production technology and the application.

Course Outcome No	Statement	Knowledge Level (KL)
CO1	Know about a fuel, classify them and compare different types of fuels and describe their testing methods. Explain the coke making process, list out the properties and its by-productsrecovery and suggest methods for decreasing environmental pollution and energy consumption.	K1
CO2	Apply principles of heat and mass transfer to basic engineering systems and understand thebasic concepts and laws of the three modes of heat transfer and apply analytical techniques to the solution of conduction heat-transfer problems.	K3
CO3	Classify and explain construction and working of different furnaces. Analyze the causes ofheat losses in furnaces and suggest methods of minimization of heat loss and waste heat recovery.	K6

CO4	Describe the operation of a thermocouple. Describe various temperature-measuring devices	K4
CO5	thermometers and pyrometers. Discuss the principles that govern noncontact thermal measurements and describe the operation of optical and radiation pyrometers.	K2
CO6	Explain various manufacturing and testing processes of refractories. Itemize many examples of metallurgical refractories under different categories, their main properties and applications. Link inherent properties of the refractory mineral and how it affects the production technology and the application.	K3

KL – Bloom's Knowledge Level (K_1, K_2, K_3, K_4, K_5, K_6)
K_1- Remember, K_2 – Understand, K_3 – Apply, K_4 – Analyze, K_5- Evaluate, K_6 – Create

Course Articulation Matrix: (Mapping of COs with POs & PSOs)

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3			3				2	1			
CO2	2				1		1	3	3			
CO3	3		2	3				1	1			
CO4												
CO5												
CO6												
CO Average	2.66		2	3	1		1	2	1.66			

3 - High; 2 - Medium; 1 – Low

PRODUCTION & OPERATIONS MANAGEMENT

Subject Code: -	**BTMT 603**	**IA Marks**	**40**
Number of Lecture Hours/Week:-	**04**	**Term End Exam Marks**	**60**
Total Number of Lecture Hours: -	**45**	**CREDITS**	**03**

Objectives:
1. To provide knowledge on machines and related tools for manufacturing various components.
2. To understand the relationship between process and system in manufacturing domain.
3. To identify the techniques for the quality assurance of the products and the optimality of the process in terms of resources and time management.

Contents

Module -1 (05 hours)
Introduction: Scope of production management. Production system and resources (machines, tooling, etc.); Types of production (batch, flow and unit), Roles of line supervisors and production managers.

Module -2 (10 hours)
Project Management: Project life cycle: concept phase (RFQ, Quotations, Proposals), Project initiations, DPR preparation (project value, business case development and feasibility study); Project planning (obtaining resources, acquiring financing and procuring required materials); Project team,

producing quality outputs, handling risk, acceptance criteria; Project execution (allocation of resources, scheduling, building deliverables); Project Monitoring and control: Project networks, progress review (physical and financial), CPM and PERT, critical path, re-scheduling; Project closure: acceptance of project deliverable; Analytics: Performance, capability aggregation, cost benefit analysis, variability analysis, Output-outcome analysis, project documentation, best practices, and depository.

Module – 3 (10 hours)

Production Planning and Control: Production planning, Process planning, Resource planning, demand-utility mapping (production capability index, forecasting models, aggregate production planning, materials requirement planning); Inventory Management: Economic order Quantity, discount models, stochastic inventory models, practical inventory control models, JIT; Supply chain and management.

Module - 4 (10 hours)

Factory Management: Factory layout: line balancing, material flow and handling, Lean and green manufacturing, Human resource management, Training need analysis, Advantage and opportunities for Digitalization, Advanced factory systems: TQM; Important acts, regularities and safety norms, Reliability assessment of processes, Block chain, Energy management, Efficiency & throughput, Overall equipment effectiveness. Process capability, lean manufacturing.

Module -5 (10 hours)

Operation Management: Linear programming, objective function and constraints, graphical method, Simplex and duplex algorithms, transportation assignment; Simple queuing theory models; Traveling Salesman problem; Network models: shortest route, minimal spanning tree, maximum flow model.

Text /Reference Books:

1. L.J. Krajewski and L.P Ritzmen, Operations Management: Strategy and Analysis, Pearson, 2010.
2. R.B. Chase, F.R. Jacobs and N.J. Aquilano, Operations Management for Competitive Advantage, Tata McGraw Hill, 2011.
3. W. J. Hopp and M. L. Spearman, Factory Physics: Foundations of Manufacturing Management, McGraw Hill International Edition, 2008.
4. Mahadevan. B., Operations Management: Theory and Practice, Pearson, 2015.
5. Taha H. A., Operations Research, 6th Edition, PHI India, 2003.
6. M.P. Poonia, Total Quality Management, Khanna Publishing House, 2022.

Online Resources:

1 https://onlinecourses.nptel.ac.in/noc20_mg06/preview

Course Outcomes:

At the end of this course students will demonstrate the ability to

CO1. Students will be able to analyze contemporary manufacturing and service operations in a global business environment.

CO2. Students will be able to evaluate the value chain and understand the use of current management theories and tools in operations.

CO3. Students will be able to apply the knowledge gained to solve practical problems in production planning, inventory management, and quality control.

CO4. Students will be able to analyze data and make effective decisions in various operations management contexts.

CO5. Students will be able to understand the role of sustainability in operations management and its

impact on the environment and society.

Course Outcome No	Statement	Knowledge Level (KL)
CO1	Students will be able to analyze contemporary manufacturing and service operations in a global business environment.	K_1
CO2	Students will be able to evaluate the value chain and understand the use of current management theories and tools in operations.	K_2
CO3	Students will be able to apply the knowledge gained to solve practical problems in production planning, inventory management, and quality control.	K_3
CO4	Students will be able to analyze data and make effective decisions in various operations management contexts.	K_5
CO5	Students will be able to understand the role of sustainability in operations management and its impact on the environment and society.	K_2

KL- Bloom's Knowledge Level (K_1, K_2, K_3, K_4, K_5, K_6)

K_1-Remember, K_2- Understand, K_3- Apply, K_4- Analyze, K_5- Evaluate, K_6- CreateMaterials characterization techniques

Course Articulation Matrix: (Mapping of COs with POs & PSOs)

CO	CORRELATION WITH PROGRAM OUTCOMES												CORRELATION WITH PSOs	
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	3				2			2				1	1
CO2	1			2							1			
CO3	1	2												
CO4														
C05														
CO(Average)	1.3	2.5		2		2			2		1		1	1

3 –High; 2 –Medium; 1 –Low

MATERIALS CHARACTERIZATION TECHNIQUES

Subject Code: -	**BTMT604**	**IA Marks**	**40**
Number of Lecture Hours/Week:-	**04**	**Term End Exam Marks**	**60**
Total Number of Lecture Hours: -	**60**	**CREDITS**	**04**

Course Objectives:

1. To explain and describe the various working techniques of optical microscope, Scanningand Transmission Microscopes used for evaluating material properties.
2. To explain and describe the various working techniques of XRD, SPM, AFM for evaluatingmaterial properties.
3. To differentiate and compare between various characterization techniques.

4. Obtain knowledge on the various thermal analyses techniques.

Module -1 (10 hours)
Optical Microscopy–Introduction, optical principles, Instrumentation, specimen preparation-metallographic principles, Imaging Modes, Applications, Limitations.

Module -2 (15 hours)
(a) Scanning Electron Microscopy (SEM) - Introduction, instrumentation, Contrast formation, Operational variables, Specimen Preparation, Imaging Modes, Applications, and Limitations.
(b) Transmission Electron Microscopy (TEM**) -** Introduction, instrumentation, Specimen preparation –pre thinning, final thinning, Image modes-mass density contrast, diffraction contrast, Phase contrast, Applications, Limitations.

Module -3 (10 hours)
X-Ray Diffraction (XRD) **-** Introduction, production and properties of X-ray, Absorption and diffraction, Instrumentation, determination of Structure, Crystallite size, phase diagram and residual stresses.

Module -4 (10 hours)
Thermal Analysis: Introduction, Differential thermal analysis, Differential Scanning Calorimetry, Thermogravimetry, Dilatometry, Dynamic Mechanical analysis.

Module -5 (15 hours)
Scanning Probe Microscopy (SPM), Scanning Tunneling Microscopy-Basics, Probe Tips, Working environment, operational modes, Applications, Limitations.
Atomic Force Microscopy (AFM) – Basic Principles, instrumentation, operational modes, Applications, Limitations.

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

CO1. Able to use metallurgical microscopes to analyze the experimental results.
CO2. Understand the various specimen preparation techniques for SEM, TEM and analyze the experimental results.
CO3. Describe the construction of XRD machine and understand its principle and analyze / interpret the experimental results.
CO4. Conduct characterization measurement by thermal analysis and solve problem using the thermo dynamic principles.
CO5. Knowledge on thermal analyses methods such as DSC, calorimetry and dilatometry etc.,
CO6. Analyze, evaluate and interpret data and solve practical characterization problems using modern tools like SPM, AFM etc
CO7. Able to use metallurgical microscopes to analyze the experimental results.

Course Outcome No	Statement	Knowledge Level (K)
CO1	Able to use metallurgical microscopes to analyze the experimental results.	K1
CO2	Understand the various specimen preparation techniques for SEM,	K3

	TEM and analyze theexperimental results.	
CO3	Describe the construction of XRD machine and understand its principle and analyze /interpret the experimental results.	K6
CO4	Conduct characterization measurement by thermal analysis and solve problem using thermodynamic principles.	K4
CO5	Knowledge on thermal analyses methods such as DSC, calorimetry and dilatometry etc.,	K2
CO6	Analyze, evaluate and interpret data and solve practical characterization problems usingmodern tools like SPM, AFM etc.	K4
CO7	Able to use metallurgical microscopes to analyze the experimental results.	K3

KL – Bloom's Knowledge Level (K_1, K_2, K_3, K_4, K_5, K_6)
K_1- Remember, K_2 – Understand, K_3 – Apply, K_4 – Analyze, K_5- Evaluate, K_6 – Create

Course Articulation Matrix: (Mapping of COs with POs & PSOs)

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3			3				2	1			
CO2	2				1		1	3	3			
CO3	3		2	3				1	1			
CO4												
CO5												
CO6												
CO7												
CO Average	2.66		2	3	1		1	2	1.66			

3- High; 2- Medium; 1- Low

Text Books:

1. Experimental Techniques in Physical Metallurgy, V.T. Cherepin and A.K. Mallik, Asia Publishing House, 1967.
2. Thermal Analysis of Materials - Robert F. Speyer, published by Marcel Dekker, Inc. New York, 1994.

Reference Books:

1. Electron Microprobe Analysis - S.J.B. Reed, Cambridge University Press, 1975.
2. Materials Characterization, ASM Hand book, vol -10, ASM International, 2019.

ENVIRONMENTAL SCIENCE

Subject Code: -	**BTESC605**	**IA Marks**	**40**
Number of Lecture Hours/Week:-	**03**	**Term End Exam Marks**	**60**
Total Number of Lecture Hours: -	**45**	**CREDITS**	**03**

Course Objectives:

1. Understanding the importance of ecological balance for sustainable development.
2. Understanding the impacts of developmental activities and mitigation measures.
3. Understanding the environmental policies and regulations

Module – 1 (05 hours)

Ecosystems: Definition, Scope, and Importance of ecosystem. Classification, structure, and function of an ecosystem, Food chains, food webs, and ecological pyramids. Flow of energy, Biogeochemical cycles, Bioaccumulation, Biomagnification, ecosystem value, services and carrying capacity, Field visits.

Module – 2 (10 hours)

Natural Resources: Classification of Resources: Living and Non-Living resources, water resources: use and over utilization of surface and ground water, floods and droughts, Dams: benefits and problems. **Mineral resources:** use and exploitation, environmental effects of extracting and using mineral resources, Land resources: Forest resources, Energy resources: growing energy needs, renewable and non-renewable energy sources, use of alternate energy source, case studies.

Module – 3 (10 hours)

Biodiversity and Biotic Resources: Introduction, Definition, genetic, species and ecosystem diversity. Value of biodiversity; consumptive use, productive use, social, ethical, aesthetic and optional values. India as a mega diversity nation, Hot spots of biodiversity. Field visit. Threats to biodiversity: habitat loss, poaching of wildlife, man-wildlife conflicts; conservation of biodiversity: In-Situ and Ex-situ conservation. National Biodiversity act.

Module – 4 (10 hours)

Environmental Pollution and Control Technologies: Environmental Pollution: Classification of pollution, Air Pollution: Primary and secondary pollutants, Automobile and Industrial pollution, Ambient air quality standards. Water pollution: Sources and types of pollution, drinking water quality standards. Soil Pollution: Sources and types, Impacts of modern agriculture, degradation of soil. Noise Pollution: Sources and Health hazards, standards, Solid waste: Municipal Solid Waste management, composition and characteristics of e-Waste and its management. Pollution control technologies: Wastewater Treatment methods: Primary, secondary and Tertiary.

Overview of air pollution control technologies, Concepts of bioremediation. Global Environmental Issues and Global Efforts: Climate change and impacts on human environment. Ozone depletion and Ozone depleting substances (ODS). Deforestation and desertification. International conventions / Protocols: Earth summit, Kyoto protocol, and Montréal Protocol. NAPCC-GoI Initiatives.

Module – 5 (10 hours)

Environmental Policy, Legislation & EIA: Environmental Protection act, Legal aspects Air Act- 1981, Water Act, Forest Act, Wild life Act, Municipal solid waste management and handling rules, biomedical waste management and handling rules, hazardous waste management and handling rules. EIA: EIA structure, methods of baseline data acquisition. Overview on Impacts of air, water, biological and Socio-economical aspects. Strategies for risk assessment, Concepts of Environmental Management Plan (EMP). Towards Sustainable

Future: Concept of Sustainable Development Goals, Population and its explosion, Crazy Consumerism, Environmental Education, Urban Sprawl, Human health, Environmental Ethics, Concept of Green Building, Ecological Foot Print, Life Cycle assessment (LCA), Low carbon life style.

Course Outcomes:

At the end of the course the student will be able to:

CO1. Based on this course, the Engineering graduate will understand /evaluate / develop technologies on the basis of ecological principles and environmental regulations which in turn helps in sustainable development.

Course Outcome No	Statement	Knowledge Level (KL)
CO1	Based on this course, the Engineering graduate will understand /evaluate / develop technologies on the basis of ecological principles and environmental regulations which in turn helps in sustainable development.	K1

KL – Bloom's Knowledge Level (K_1, K_2, K_3, K_4, K_5, K_6)

K_1- Remember, K_2 – Understand, K_3 – Apply, K_4 – Analyze, K_5- Evaluate, K_6 – Create

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3			3				2	1			
CO Average	2.66		2	3	1		1	2	1.66			

3 - High; 2 - Medium; 1 – Low

Text Books:

1. Textbook of Environmental Studies for Undergraduate Courses by Erach Bharucha for University Grants Commission.
2. Environmental Studies by R. Rajagopalan, Oxford University Press.

Reference Books:

1. Environmental Science: towards a sustainable future by Richard T. Wright. 2008 PHL Learning Private Ltd. New Delhi.
2. Environmental Engineering and science by Gilbert M. Masters and Wendell P. Ela. 2008 PHI Learning Pvt. Ltd.
3. Environmental Science by Daniel B. Botkin & Edward A. Keller, Wiley INDIA edition.
4. Environmental Studies by Anubha Kaushik, 4th Edition, New age international publishers.
5. Text book of Environmental Science and Technology - Dr. M. Anji Reddy 2007, BS Publications.
6. Introduction to Environmental Science by Y. Anjaneyulu, BS. Publications.

EMPLOYMENT ENHANCEMENT COURSE – II

Subject Code: -	**BTEEC606**	**IA Marks**	**40**
Number of Lecture Hours/Week:-	**02**	**Term End Exam Marks**	**60**
Total Number of Lecture Hours: -	**30**	**CREDITS**	**01**

Course objectives:

1. The Employment Enhancement Course - II (EEC-II) is designed to equip students with crucial skills for securing employment or pursuing entrepreneurship.
2. The course is structured around various modules, each focusing on specific skill development.

COURSE CONTENTS

MODULE 1: COMMUNICATION AND SOFT SKILLS

- Learn good communication and soft skills.
- Practicing formal introductions and understanding the importance of communication.
- Interpersonal communication, including giving and receiving feedback effectively.
- Developing verbal and non-verbal communication skills.
- Enhancing listening skills and practicing gender sensitivity.
- Workplace communication with peers, superiors, and juniors.

MODULE 2: COMPUTER BASICS AND DIGITAL LITERACY

- Understanding and recalling essential elements of computer basics and technology.
- Basic computer operations, including MS-Word and Excel basics.
- Web browsing and using search engines efficiently.
- Creating and using email accounts, including attaching documents and professional email etiquette.
- Exploring mobile applications relevant to the workplace.
- Understanding concepts like file conversion, cloud computing, and language translation.

MODULE 3: EMPLOYMENT AND SELF-EMPLOYMENT ENHANCEMENT

- Resume writing and preparation for interviews.
- Practicing technical evaluations and aptitude tests.
- Developing interview etiquette, including communication, body language, and answering questions confidently.
- Understanding and applying for apprenticeships and internships.
- Registering on government job portals and exploring job search strategies.
- Learning about career planning, exploring career pathways within a chosen sector, and anticipating challenges.

MODULE 4: ENTREPRENEURSHIP SKILLS

Introducing students to the basics of entrepreneurship and fostering an entrepreneurial mindset.

COURSE OUTCOMES:

CO1. Developing an entrepreneurial mindset and identifying opportunities.
CO2. Learning about market research, developing a Unique Value Proposition (UVP), and being resourceful.
CO3. Understanding the ease of doing business, including statutory compliances and government schemes.
CO4. Managing resources, including human resources, finance, and infrastructure.
CO5. Importance of mentorship and continuous learning in entrepreneurship.

Course Outcome No	Statement	Knowledge Level (KL)
CO1	Developing an entrepreneurial mindset and identifying opportunities.	K_1
CO2	Learning about market research, developing a Unique Value Proposition (UVP), and being resourceful.	K_2
CO3	Understanding the ease of doing business, including statutory compliances and government schemes.	K_3
CO4	Managing resources, including human resources, finance, and infrastructure.	K_5
CO5	Importance of mentorship and continuous learning in entrepreneurship.	K_2

KL- Bloom's Knowledge Level (K_1, K_2, K_3, K_4, K_5, K_6)
K_1-Remember, K_2- Understand, K_3- Apply, K_4- Analyze, K_5- Evaluate, K_6- Create

Course Articulation Matrix: (Mapping of COs with POs & PSOs)

CO	CORRELATION WITH PROGRAM OUTCOMES												CORRELATION WITH PSOs	
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	3				2			2				1	1
CO2	1			2							1			
CO3	1	2												
CO4														
C05														
CO(Average)	1.3	2.5		2		2			2		1		1	1

3 –High; 2 –Medium; 1 –Low

FUELS, FURNACES AND REFRACTORIES LAB

Subject Code: -	**BTMT602P**	**IA Marks**	**40**
Number of Lecture Hours/Week: -	**02**	**Term End Exam Marks**	**60**
Total Number of Lecture Hours: -	**30**	**CREDITS**	**01**

Course Objectives:

This laboratory course deals with:

1. Analysis of fuels and their importance.
2. Characterization of refractories.
3. Use different types of fuel testing equipment.

List of Experiments:

1. Proximate analysis of Coal (percentage of moisture, volatile matter, ash content & Fixed Carbon).
2. Ultimate analysis of Coal (Carbon, hydrogen, sulfur and oxygen).
3. Determination of Flash and Fire points of diesel using PENSKY MARTINS open and closed cup apparatus.
4. Determination of Flash and Fire points of kerosene using PENSKY MARTINS open and closed cup apparatus.
5. Determination of Flash and Fire points of diesel using ABEL's apparatus.
6. Determination of Flash and Fire points of kerosene using ABEL's apparatus.
7. Determine the effect of kinematic viscosity of lubricant oil by using Red - wood Viscometer-I.
8. Determine the effect of kinematic viscosity of lubricant oil by using Red - wood Viscometer-II.
9. Determine the calorific value of coal by using "Bomb Calorimeter".
10. Determination of apparent density of refractories.

Course Outcomes:

At the end of the course the student would be able to:

1. Gain hands-on experience on the equipment that facilitate property evaluation of fuels, and refractories.
2. Choose the fuels and refractories for specific use in construction and operation of different furnaces.
3. Select fuels, refractories to minimize overall cost of production for given applications.
4. Operate various types of fuel testing equipment and analyze the observations recorded.

MATERIALS CHARACTERIZATION TECHNIQUES LAB

Course Objectives

The course aims to:

1. Provide hands-on exposure to advanced material characterization techniques.
2. Familiarize students with the working principles, instrumentation, and sample preparation for optical, electron, and scanning probe microscopes.
3. Demonstrate X-ray diffraction techniques for crystal structure and phase analysis.
4. Introduce thermal analysis methods for studying phase transformations and material stability.
5. Develop skills in interpreting microstructural, compositional, and thermal data for engineering applications.

List of Laboratory Experiments

1. Optical Microscopy – Identification of Microstructures (Study of ferrite, pearlite, martensite, and common non-ferrous structures)
2. Specimen Preparation for Metallography (Grinding, polishing, etching, and sample mounting techniques)
3. Measurement of Grain Size Using Optical Microscopy (ASTM grain size number determination)
4. Scanning Electron Microscopy (SEM) – Surface Morphology Analysis (Demonstration and interpretation of secondary and backscattered electron images)
5. Energy Dispersive X-ray Spectroscopy (EDS) in SEM (Elemental composition analysis)
6. Transmission Electron Microscopy (TEM) – Demonstration and Image Interpretation (Observation of diffraction patterns, dislocations, and crystal defects)
7. X-ray Diffraction (XRD) – Phase Identification (Determination of crystal structure and lattice parameters)
8. XRD – Crystallite Size and Residual Stress Measurement (Using Scherrer's equation and peak shift method)
9. Differential Scanning Calorimetry (DSC) and Thermogravimetric Analysis (TGA) (Study of phase transformation temperatures, heat flow, and weight changes)
10. Atomic Force Microscopy (AFM) – Surface Topography Study (Demonstration of contact and tapping modes, interpretation of surface roughness data).

Course Outcomes

After completing the laboratory, students will be able to:

CO1. Prepare metallographic specimens and operate optical microscopes for microstructural analysis.
CO2. Measure grain size and identify various phases in ferrous and non-ferrous alloys.
CO3. Operate SEM for surface morphology study and elemental composition analysis using EDS.
CO4. Interpret TEM images for crystallographic defects and microstructural features.
CO5. Perform XRD experiments to determine crystal structure, phase composition, and lattice parameters.
CO6. Analyze crystallite size and residual stress using XRD data.

ENGINEERING PROJECT-1

BTEEC607P	**Engineering Project-1 (Literature Review)**	**0L: 0T: 4P**	**2 Credits**

Objectives:

This course is aimed to provide more weightage for project work. The project work could be done in the form of a summer project or internship in the industry or even a minor practical project in the college. Participation in any technical event/ competition to fabricate and demonstrate an innovative machine or product could be encouraged under this course.

VII-SEMESTER

FINITE ELEMENT ANALYSIS

Subject Code: -	BTMT701	IA Marks	40
Number of Lecture Hours/Week:-	04	Term End Exam Marks	60
Total Number of Lecture Hours: -	60	CREDITS	04

Course Objective:

1. To introduce the concepts of Mathematical Modeling of Engineering Problems.
2. To appreciate the use of FEM to a range of Engineering Problems.

Criteria	Description	Maximum Marks
Internal Assessment (IA)	Internal Examination	30
	Attendance/Discipline	5
	Assignment/ Seminar	5
Terminal Examination (TE)	Terminal Examination	60
Total		100
Attendance	A minimum of 75% Attendance is required to be maintained by a student to be qualified for taking up the End Semester examination. The allowance of 25% includes all types of leaves including medical leaves.	

Course Content:

Module - 1 (10 hours)
INTRODUCTION: Historical Background, Mathematical Modeling of field problems in Engineering, Governing Equations – Discrete and continuous models. Boundary, Initial and Eigen Value problems, Weighted Residual Methods, Variation Formulation of Boundary Value Problems, Ritz Technique. Basic concepts of the Finite Element Method.

Module - 2 (15 hours)
ONE-DIMENSIONAL PROBLEMS: 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 and heat transfer. Longitudinal vibration frequencies and mode shapes. Fourth Order Beam Equation, Transverse deflections and Natural frequencies of beams.

Module - 3 (15 hours)
TWO-DIMENSIONAL SCALAR VARIABLE PROBLEMS: Second Order 2D Equations involving Scalar Variable Functions, Variational formulation, Finite Element formulation, Triangular elements, Shape functions and element matrices and vectors. Application to Field Problems, Thermal problems, Torsion of Non circular shafts, Quadrilateral elements, Higher Order Elements.

Module -4 (10 hours)
TWO-DIMENSIONAL VECTOR VARIABLE PROBLEM: Equations of elasticity, Plane stress, plane strain and ax symmetric problems. Body forces and temperature effects – Stress calculations – Plate and shell elements. Body forces and temperature effects – Stress calculations – Plate and shell elements.

Module -5 (10 hours)
ISOPARAMETRIC FORMULATION: Natural co-ordinate systems, Isoparametric elements, Shape functions for iso parametric elements, One and two dimensions. Serendipity elements –

Numerical integration and application to plane stress problems – Matrix solution techniques. Solutions Techniques to Dynamic problems – Introduction to Analysis Software.

Text /Reference Books:

1. Reddy. J.N., "An Introduction to the Finite Element Method", 3rd Edition, Tata McGraw-Hill, 2025
2. Seshu, P, "Text Book of Finite Element Analysis", Prentice-Hall of India Pvt. Ltd., New Delhi, 2007.

Course Outcomes:

At the end of this course students will demonstrate the ability

CO1. Upon completion of this course, students will understand the function of each automobile component and also have a clear idea about the overall vehicle performance.
CO2. Apply finite element formulations to solve one-dimensional Problems.
CO3. Apply finite element formulations to solve two-dimensional scalar Problems.
CO4. Apply finite element method to solve two-dimensional Vector problems.
CO5. Apply finite element method to solve problems on iso parametric element and dynamic Problems.

Course Outcome No	Statement	Knowledge Level (KL)
CO1	Upon completion of this course, students will understand the function of each automobile component and also have a clear idea about the overall vehicle performance.	K_1
CO2	Apply finite element formulations to solve one-dimensional Problems.	K_2
CO3	Apply finite element formulations to solve two-dimensional scalar Problems.	K_3
CO4	Apply finite element method to solve two-dimensional Vector problems.	K_5
CO5	Apply finite element method to solve problems on iso parametric element and dynamic Problems.	K_2

KL- Bloom's Knowledge Level (K_1, K_2, K_3, K_4, K_5, K_6)
K_1-Remember, K_2- Understand, K_3- Apply, K_4- Analyze, K_5- Evaluate, K_6- Create

Course Articulation Matrix: (Mapping of COs with POs & PSOs)

CO	CORRELATION WITH PROGRAM OUTCOMES												CORRELATION WITH PSOs	
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	3				2			2				1	1
CO2	1			2							1			
CO3	1	2												
CO4														
C05														
CO(Average)	1.3	2.5		2		2			2		1		1	1

3 –High; 2 –Medium; 1 –Low

(OPEN ELECTIVE COURSE)

ARTIFICIAL INTELLIGENCE & MACHINE LEARNING

Subject code: -	**Open Elective**	**IA marks**	**40**
Number of Lecture Hours/Week:-	**03**	**Term End Exam Marks**	**60**
Total Number of Lecture Hours: -	**45**	**CREDITS**	**03**

Course Objective:

1. To have a thorough understanding of classical and modern AI applications.
2. To be able to implement a wide range of AI concepts using Prolog.
3. Understand non-classical AI approaches such as genetic algorithms and neural networks.
4. To be able to assess the potential of AI in research and real-world environment

Assessment Plan:

Criteria	Description	Maximum Marks
Internal Assessment (IA)	Internal Examination	30
	Attendance/Discipline	5
	Assignment/ Seminar	5
Terminal Examination (TE)	Terminal Examination	60
Total		100
Attendance	A minimum of 75% Attendance is required to be maintained by a student to be qualified for taking up the End Semester examination. The allowance of 25% includes all types of leaves including medical leaves.	

Course Content:

Module -1 (10 hours)
INTRODUCTION: History and foundations of AI, Problem solving: Uninformed and informed Search; Constraint Satisfaction Problems and Constrained Optimization problems (complete and incomplete techniques).

Module - 2 (07 hours)
ADVERSARIAL SEARCH: Two players games, games with uncertainty; Decision support systems and technologies, Knowledge representation, Reasoning, Expert systems Contents (2/2), Planning(basics).

Module - 3 (10 hours)
MACHINE LEARNING BASICS: Decision trees, Ensemble learning, Reinforcement learning, Evolutionary computation, Neural networks, Problems, data, and tools; Visualization;

Module – 4 (10 hours)
LINEAR REGRESSION: Gradient descent; closed form; normal equations; features, Over fitting and complexity; training, validation, test data, and introduction to Matlab.

Module – 5 (08 hours)
CLASSIFICATION PROBLEMS: Decision boundaries; Probability and classification, Bayes optimal decisions, Naive Bayes and Gaussian class-conditional distribution.

TEXT BOOKS

1. Russell, Norvig, Artificial intelligence: A modern approach, 2nd edition. Pearson/Prentice Hall.

REFERENCE BOOKS

1. EthemAlpaydin, Introduction to Machine Learning, Second Edition,

Course Outcome

CO1. Identify problems that are amenable to solution by AI methods.
CO2. Design and carry out an empirical evaluation of different algorithms on a problem formalization, and state the conclusions that the evaluation supports.
CO3. Have a good understanding of the fundamental issues and challenges of machine learning: data, model selection, model complexity, etc.
CO4. able to design and implement various machine learning algorithms in a range of real-world applications.
CO5. Machine Learning algorithms and the paradigms of supervised and un-supervised learning.

Course Outcome No	Statement	Knowledge Level (KL)
CO1	Identify problems that are amenable to solution by AI methods.	K_1
CO2	Design and carry out an empirical evaluation of different algorithms on a problem formalization, and state the conclusions that the evaluation supports.	K_2
CO3	Have a good understanding of the fundamental issues and challenges of machine learning: data, model selection, model complexity, etc.	K_3
CO4	able to design and implement various machine learning algorithms in a range of real-world applications.	K2
CO5	Machine Learning algorithms and the paradigms of supervised and un-supervised learning.	K2

KL- Bloom's Knowledge Level (K_1, K_2, K_3, K_4, K_5, K_6)

K_1-Remember, K_2- Understand, K_3- Apply, K_4- Analyze, K_5- Evaluate, K_6- Create

Course Articulation Matrix: (Mapping of COs with POs & PSOs)

CO	CORRELATION WITH PROGRAM OUTCOMES												CORRELATION WITH PSOs	
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12	PSO1	PSO2
CO1	3						1		1					
CO2		1	2											
CO3				3									1	
CO4	3		3								2			
CO5	3	3		2										2
CO(Average)	3	2	2.5	2.5			1		1		2		1	2

3 –High; 2 –Medium; 1 –Low

CYBER SECURITY LAWS, STANDARDS & IPR

Subject Code: -	**Open Elective**	**IA Marks**	**40**
Number of Lecture Hours/Week: -	**03**	**Term End Exam Marks**	**60**
Total Number of Lecture Hours: -	**45**	**CREDITS**	**03**

Course Objective:

1. Cyber Security is to achieve these three elements (Confidentiality, Integrity and Availability) and also knows as CIA Triad. For any organization, it's essential to protect its data, information using security tools.
2. Implement Cyber Security Best Practices and Risk Management

Assessment Plan:

Criteria	Description	Maximum Marks
Internal Assessment (IA)	Internal Examination	30
	Attendance/Discipline	5
	Assignment/ Seminar	5
Terminal Examination (TE)	Terminal Examination	60
Total		100
Attendance	A minimum of 75% Attendance is required to be maintained by a student to be qualified for taking up the End Semester examination. The allowance of 25% includes all types of leaves including medical leaves.	

Course Content:

Module -1 (15 hours)

BASIC OF COMPUTER AND CYBER SECURITY: History of Computers, Areas of Application Computers and its components, Application Software and System Software

Introduction to Operating System. Basics of Networks and internet, Types of Network, Definition of Cyber Security, Search Engines, E –mails and WWW; Internetworking Devices, Internet Service provider, IP Address, Working of Email system, Domain Name System, Blogs, Peer to peer sharing, Computer & Cyber Security:(a) Types of Attacks,(b) Network Security(c) Overview of Security threats,(d) Hacking Techniques,(e) Password cracking(f) Insecure Network connections,(g) Malicious code(h) Concept of Fire wall Security.

Module -2 (10 hours)

INFORMATION TECHNOLOGY LAW (CYBER LAW): Evolution of the IT Act, Genesis and Necessity. Salient features of the IT Act, 2000, various authorities under IT Act and their powers. ; Penalties & Offences, amendments. Different kinds of cyber law in Indian history.

Module -3 (10 hours)

CYBER SPACE JURISDICTION: (a) Jurisdiction issues under IT Act, 2000.(b) Traditional principals of Jurisdiction(c) Extra-terrestrial Jurisdiction(d) Case Laws on Cyber Space Jurisdiction.

Module -4 (10 hours)

CYBER CRIME AND INVESTIGATION PROCEDURES: Cyber Forensic and Computer Crimes and types. Crimes targeting Computers: Definition of Cyber Crime & Computer related Crimes, Classification & Differentiation between traditional crime and cybercrimes. (a) Data Theft (b) Hacking, (c) Spreading Virus & Worms (d) Phishing (e) Cyber Stalking / Bullying (f) Identity Theft

& Impersonation (g) Credit card & Online Banking Frauds, Reasons for Cyber Crimes. Cyber Criminal Mode and Manner of Committing Cyber Crime Prevention of Cyber Crimes & Frauds Critical analysis & loop holes of The IT Act,2000Cyber Crimes: Freedom of speech in cyber space & human right issue Investigation of Cyber Crimes, Investigation of malicious applications, Agencies for investigation in India, their powers and their constitution as per Indian Laws.

TEXT BOOKS

1. Cyber Law & Cyber Crimes by Advocat Prashant Mali; Snow White publications, Mumbai
2. Cyber Law in India by Farooq Ahmad; Pioneer Books
3. Information Technology Law and Practice by Vakul Sharma; Universal Law Publishing Co. Pvt. Ltd.
4. The Indian Cyber Law by Suresh T. Vishwanathan; Bharat Law House New Delhi
5. Guide to Cyber and E – Commerce Laws by P.M. Bukshi and R.K. Suri; Bharat Law House, New Delhi
6. Guide to Cyber Laws by Rodney D. Ryder; Wadhwa and Company, Nagpur
7. The Information Technology Act, 2000; Bare Act – Professional Book Publishers, New Delhi

FREFERENCE BOOKS

1. Computer Forensics: Principals and Practices by Linda Volonino, Reynaldo Anzaldua and Jana Godwin; Pearson Prentice – Hall 2007
2. First Responder"s Guide to Computer Forensics by Richard Nolan rt al; Carnegi Mellon, 2005.
3. Digital Evidence and Computer Crime, 2nd Ed. By Eoghan Casey; Academic Press, 2004.
4. The Regulation of Cyberspace by Andrew Murray, 2006; Rutledge – Cavendish.
5. Scene of the Cybercrime: Computer Forensics Handbook by Syngress.
6. Security and Incident Response by Keith J. Jones, Richard Bejtloich and Curtis W.Rose

Course Outcome

CO1. Conduct a cyber security risk assessment
CO2. Measure the performance and troubleshoot cyber security systems.
CO3. Implement cyber security solutions.
CO4. Students able to use cyber security, information assurance, and cyber/computer forensics software/tools.

Course Outcome No	Statement	Knowledge Level (KL)
CO1	Conduct a cyber security risk assessment	K_1
CO2	Measure the performance and troubleshoot cyber security systems.	K_2
CO3	Implement cyber security solutions.	K_3
CO4	Students able to use cyber security, information assurance, and cyber/computer forensics software/tools.	K_3

KL- Bloom's Knowledge Level (K_1, K_2, K_3, K_4, K_5, K_6)
K_1-Remember, K_2- Understand, K_3- Apply, K_4- Analyze, K_5- Evaluate, K_6- Create

Course Articulation Matrix: (Mapping of COs with POs & PSOs)

CO	CORRELATION WITH PROGRAM OUTCOMES												CORRELATION WITH PSOs	
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12	PSO1	PSO2
CO1	3						1		1					
CO2		1	2											
CO3				3									1	
CO4	3		3								2			
CO(Average)	3	1	2.5	3			1		1		2		1	

3 –High; 2 –Medium; 1 –Low

PROJECT MANAGEMENT

Subject Code: -	**Open Elective**	**IA Marks**	**40**
Number of Lecture Hours/Week: -	**03**	**Term End Exam Marks**	**60**
Total Number of Lecture Hours: -	**45**	**CREDITS**	**03**

Course Objective:

1. To enable the students to study the evolution of Management, to study the functions and principles of management and to learn the application of the principles in an organization.

Assessment Plan:

Criteria	Description	Maximum Marks
Internal Assessment (IA)	Internal Examination	30
	Attendance/Discipline	5
	Assignment/ Seminar	5
Terminal Examination (TE)	Terminal Examination	60
Total		100
Attendance	A minimum of 75% Attendance is required to be maintained by a student to be qualified for taking up the End Semester examination. The allowance of 25% includes all types of leaves including medical leaves.	

Course Content:

INTRODUCTION TO MANAGEMENT AND ORGANIZATIONS: Definition of Management – Science or Art – Manager Vs Entrepreneur – types of managers – managerial roles and skills – Evolution of Management – Scientific, human relations, system and contingency approaches – Types of Business organization – Sole proprietorship, partnership, company-public and private sector enterprises – Organization culture and Environment – Current trends and issues in Management.

PLANNING: Nature and purpose of planning – planning process – types of planning – objectives – setting objectives – policies – Planning premises – Strategic Management – Planning Tools and Techniques – Decision making steps and process.

ORGANISING: Nature and purpose – Formal and informal organization – organization chart – organization structure – types – Line and staff authority – departmentalization – delegation of authority –

centralization and decentralization – Job Design – Human Resource Management – HR Planning, Recruitment, selection, Training and Development, Performance Management, Career planning and management.

DIRECTING: Foundations of individual and group behaviour – motivation – motivation theories – motivational techniques – job satisfaction – job enrichment – leadership – types and theories of leadership – communication – process of communication – barrier in communication – effective communication – communication and IT.

CONTROLLING: System and process of controlling – budgetary and non-budgetary control techniques – use of computers and IT in Management control – Productivity problems and management – control and performance – direct and preventive control – reporting

TEXT BOOKS

1. Stephen A. Robbins & David A. Decenzo& Mary Coulter, "Fundamentals of Management" 7th Edition, Pearson Education, 2011.
2. Robert Kreitner&MamataMohapatra, "Management", Biztantra, 2008.

REFERENCE BOOKS

1. Harold Koontz & Heinz Weihrich "Essentials of management" Tata Mc Graw Hill, 1998.
2. Tripathy PC & Reddy PN, "Principles of Management", Tata McGraw Hill, 1999.

Course Outcome

CO1. Understand key concepts of project management and project lifecycle
CO2. Apply the Project Management Techniques.
CO3. Describe the Project Management Planning Process.
CO4. Project Management Team concepts.

Course Outcome No	Statement	Knowledge Level (KL)
CO1	Understand key concepts of project management and project lifecycle	K_1
CO2	Apply the Project Management Techniques.	K_2
CO3	Describe the Project Management Planning Process.	K_3
CO4	Project Management Team concepts.	K_3

KL- Bloom's Knowledge Level (K_1, K_2, K_3, K_4, K_5, K_6)

K_1-Remember, K_2- Understand, K_3- Apply, K_4- Analyze, K_5- Evaluate, K_6- Create

Course Articulation Matrix: (Mapping of COs with POs & PSOs)

CO	CORRELATION WITH PROGRAM OUTCOMES												CORRELATION WITH PSOs	
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12	PSO1	PSO2
CO1	3						1		1					
CO2		1	2											
CO3				3									1	
CO4	3		3								2			
CO(Average)	3	1	2.5	3			1		1		2		1	

3 –High; 2 –Medium; 1 –Low

INTRODUCTION TO INSTRUMENTATION

Subject Code: -	Open Elective	IA Marks	40
Number of Lecture Hours/Week: -	03	Term End Exam Marks	60
Total Number of Lecture Hours: -	45	CREDITS	03

Course Objectives:

To have a knowledge of:

1. Electronic Instruments.
2. Pressure measurements.
3. Flow measurements.
4. Vibration, Viscosity and Humidity Level measurement.
5. Various analyzers.

Module -1

Electronic Instruments: CRO- Storage oscilloscope – Digital voltage meter (DVM) –Digital multi meter – XY Recorder, Strip chart recorder – Digital recording- Data logger – Introduction to virtual instrumentation.

Module -2

Pressure Measurements: Unit of Pressure – Manometers- Different types, - Elastic type pressure gauges – Bourdon tube – Bellows – Diaphragm – Elastic elements with LVDT and strain gauge – Capacitive type pressure gauge – Measurement of vacuum – McLeod gauge – Thermal conductivity gauge – Ionization gauge.

Module -3

Flow Measurements: Flow meters – Variable head type flow meter – Orifice plate – Venturetube – Positive displacement flow meter: Nutating disc, Reciprocating piston, oval gear and helix type flow meter – Rota meter – Mass flow meters.

Module -4

Vibration, Viscosity, Humidity, Level Measurement: Mechanical type vibration measuring instruments – Seismic instruments as an accelerometer- Vibrometers – Viscosity – Saybolt viscometer. Humidity – Hot wire electro type hygro meter - Dew cell – Electrolysis type hygrometer.

Module -5

Analyzers: Dissolved Analyzer: Conductivity meter – pH meter – Dissolved oxygen analyzer – Sodium analyzer – Silica analyzer – Turbidity meter – Gas analyzer – NOx analyzer – H_2S analyzer – CO and CO_2 monitor, Dust & Smoke measurement.

Course Outcomes:

At the end of the course the student will be able to:

CO1. The knowledge gained on electronic; pressure, flow and vibration measurement will provide a strong platform to understand the concepts on these subjects for further learning.

CO2. Comprehend various pressure measurements.
CO3. Make accuracy statements for various types of measurements.
CO4. Differentiate
CO5. To be able to describe the operation of instruments used for various gas, liquid and solid materials.
CO6. The knowledge gained on electronic; pressure, flow and vibration measurement will provide a strong platform to understand the concepts on these subjects for further learning.

Course Outcome No	Statement	Knowledge Level (KL)
CO1	The knowledge gained on electronic; pressure, flow and vibration measurement will provide a strong platform to understand the concepts on these subjects for further learning.	K1
CO2	Comprehend various pressure measurements.	K3
CO3	Make accuracy statements for various types of measurements.	K1
CO4	Differentiate	K4
CO5	To be able to describe the operation of instruments used for various gas, liquid and solidmaterials.	K3
CO6	The knowledge gained on electronic; pressure, flow and vibration measurement will provide a strong platform to understand the concepts on these subjects for further learning.	K2

KL – Bloom's Knowledge Level (K_1, K_2, K_3, K_4, K_5, K_6)
K_1- Remember, K_2 – Understand, K_3 – Apply, K_4 – Analyze, K_5- Evaluate, K_6 – Create

Course Articulation Matrix: (Mapping of COs with POs & PSOs)

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3			3				2	1			
CO2	2				1		1	3	3			
CO3	3		2	3				1	1			
CO4												
CO5												
CO6												
CO Average	2.66		2	3	1		1	2	1.66			

3 - High; 2 - Medium; 1 – Low

Text Books:

1. Alan S. Morrris. Principles of Measurement and Instrumentation, Prentice-Hall of India Pvt., Ltd. New Delhi, 1999.
2. Ernest O Doeblin. Measurement Systems Application & Design, Tata McGraw Hill Publishing Co., New. Delhi, 1999.

Reference Books:

1. Murthy, D.V.S. Transducers and Instrument and Instrumentation, Prentice Hall of India Pvt. Ltd. New Delhi.
2. Patranabir, D. Principle of Industrial Instrumentation, Tata McGraw Hill Publishing Co., New Delhi 1999.
3. Jain, R.K. Mechanical and Industrial Measurements, Khanna Publishing, New Delhi, 1999.
4. Liptak B.G. Instrumentation Engineers Hand Book (Measurement), Chilton Book Co., 1994.

NUCLEAR METALLURGY
(Open Elective)

Subject Code: -	**Open Elective**	IA Marks	40
Number of Lecture Hours/Week:-	03	Term End Exam Marks	60
Total Number of Lecture Hours: -	45	CREDITS	03

Course Objectives:

1. To explain and describe the basics of nuclear technology and relevance of metallurgy to nuclear reactors.
2. To gain a working knowledge of extraction of nuclear metals like Uranium, Thorium, and Beryllium.
3. To understand principles of nucleation reactors and its safety.

Module -1

Elementary nuclear physics and chemistry: Structure of nucleus, radioactivity, binding energy: nuclear interaction; fission and fusion: nuclear reaction; energy release and chain reactions; neutron cross-section; multiplication and criticality concepts and factors.

Module -2

Mechanisms of moderation, radiation detection, radiation effects on fissile and non-fissile materials; radiation damage and radiation growth; thermal cycling; protection against radiations.

Module -3

Types of reactors and classification.

Considerations in selection and properties of common materials used as nuclear fuels, their physical and chemical properties; canning materials; coolants; control rods; reflectors shielding materials and Clad tubes

Module -4

Occurrence and general characteristics of nuclear minerals. Flow sheets of processing of nuclear minerals for the production of nuclear grade Uranium, Thorium, Beryllium and Zirconium with emphasis on basic scientific principles involved.

Module -5

Production and enrichment of uranium, Fabrication of fuel elements. Irradiated fuel processing for recovery of Plutonium.

Nuclear power production in India and its economics.

Course Outcomes:

At the end of the course the student will be able to:

CO1. Use fundamental concepts of physics and chemistry to know the basics of nuclear energy, understand the use of nuclear energy as a major source of energy.

CO2. Recognize the predominant mechanisms for materials failure in radiation environments, and understand the fundamentals of radiation damage events and gain knowledge about the safety measures and control.

CO3. Understand the guiding principles of reactor safety and report findings including recommendations for improvement.

CO4. Understand materials design issues in various reactor configurations and recognize the materials used in different types of reactor applications.

CO5. Understand the manufacturing processes and fabrications methods used for various materials used in reactors.

CO6. Work and communicate effectively in diverse and multi-disciplinary teams and be aware of modern professional, ethical, and societal issues as well as recognize the need for lifelong learning.

Course Outcome No	Statement	Knowledge Level (KL)
CO1	Use fundamental concepts of physics and chemistry to know the basics of nuclear energy, understand the use of nuclear energy as a major source of energy.	K1
CO2	Recognize the predominant mechanisms for materials failure in radiation environments, and understand the fundamentals of radiation damage events and gain knowledge about the safety measures and control.	K3
CO3	Understand the guiding principles of reactor safety and report findings including recommendations for improvement.	K1
CO4	Understand materials design issues in various reactor configurations and recognize the materials used in different types of reactor applications.	K4
CO5	Understand the manufacturing processes and fabrications methods used for various materials used in reactors.	K3
CO6	Work and communicate effectively in diverse and multi-disciplinary teams and be aware of modern professional, ethical, and societal issues as well as recognize the need for lifelong learning.	K2

KL – Bloom's Knowledge Level (K_1, K_2, K_3, K_4, K_5, K_6)

K_1- Remember, K_2 – Understand, K_3 – Apply, K_4 – Analyze, K_5- Evaluate, K_6 – Create

Course Articulation Matrix: (Mapping of COs with POs & PSOs)

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3			3				2	1			
CO2	2				1		1	3	3			
CO3	3		2	3				1	1			
CO4												
CO5												
CO6												
CO Average	2.66		2	3	1		1	2	1.66			

3 - High; 2 - Medium; 1 – Low

Text Books:

1. Metallurgy in Nuclear Power Technology – J.C.Wright, published by Iliffe Books Ltd., 1962.
2. Nuclear Reactor Metallurgy – Wilkinson, WD and Murphy, WF. Published by D.Van Nostrand company, 1958.

Reference Books:

1. Symposium on Rare Materials - Indian Institute of Metals, 1957.
2. Nuclear Chemical Engineering, 2nd Edition - Manson Bendict and Thomas Pigford published by McGraw-Hill Education, 1981.
3. Nuclear Reactor General Metallurgy - B. N. Kuznetsov Sevryukov, B. Kuzmin, Chelishchev - Peace Publishers, 1965.

COMPUTATIONAL MATERIALS ENGINEERING
(Open Elective)

Subject Code: -	**Open Elective**	IA Marks	40
Number of Lecture Hours/Week: -	03	Term End Exam Marks	60
Total Number of Lecture Hours: -	45	CREDITS	03

Course objective:

1. This course introduces computational methods in the domain of metallurgical engineering.
2. To understand the structure property correlations in materials engineering.
3. To understand evolution of materials structure and to control material properties.
4. To calculate the miscellaneous problems by using computational techniques.

Module - 1

Introduction, **Tools of the trade: a short tutorial introduction:** The C programming language, GNU plot – the plotting freeware, GNU Octave for computations and plotting, Introduction to FEM, FDM, FVM and Computer packages: MATLAB, Sci Lab. Plotting, Fitting, Interpolation, Numerical integration, Numerical differentiation.

Module -2

Structure and Thermodynamics: Basics of Mathematical Modelling-Deterministic and stochastic / probabilistic models. Structure and defects. Computing free energy of common metallurgical systems from enthalpy and entropy or heat capacity and determination of temperature of reduction of metal oxides. Regular solution model.

Module - 3

Phase Transformations: Mathematical formulation of Solid-state processes of Heat treatment & Microstructure evolution, Diffusion and precipitate growth kinetics. Transport phenomena-based Modelling: model formulation based on heat, mass and momentum transfer, governing equations and boundary conditions. Spinodal decomposition, Classical Molecular Dynamics Modelling and simulations and its applications in materials, Monte Carlo simulations: phase separation and ordering.

Module -4

Phase-Field and Heat-Mass Transfer: Mathematical formulation of Liquid state Metallurgical Processes of Iron Making, Primary Steel Making and Secondary Steel Making using Momentum, Mass and Energy Balance. Principles of Computational Fluid flow and setting up the governing equation with boundary conditions. Formulation of Laminar and Turbulent flows. Case Studies of Tapping of Liquid steel, melting behaviour of additions, IGP. Computation of % CO/CO_2 at different heights with a given function of temperature profile along the height of BF and Simulations of Blast furnace reduction reactions at various heights. Mathematical Modeling of Solidification of Steel in Sand Moulds, Ingot Moulds & Concast.

Module -5

New approach: Optimization and control. Elements of modern artificial intelligence (AI) related techniques. Introduction to Genetic Algorithm and Artificial Neural Nets. Dis-critized Methods of Taylor's series expansion, polynomial Interpolation and least square approximation for numerical computation of Nonlinear algebraic equations, ODE & PDE. Statistical methods for validating models.

Course Outcomes:

At the end of the course the student will be able to:

CO1. Analyze a metallurgical problem to create a well posed numerical problem.

CO2. Identify initial and boundary conditions of a problem relevant to materials domain.

CO3. Propose a solution procedure for a numerical problem in the domain of materials engineering.

CO4. Demonstrate ability to quantify a materials engineering problem through numerical analysis.

CO5. Select materials for specific applications and also to design advanced materials for new applications.

CO6. To use preferred tools at electronic, continuum and structural levels.

Course Outcome No	Statement	Knowledge Level (KL)
CO1	Analyse a metallurgical problem to create a well posed numerical problem.	K1
CO2	Identify initial and boundary conditions of a problem relevant to materials domain.	K3
CO3	Propose a solution procedure for a numerical problem in the domain of materialsengineering.	K1
CO4	Demonstrate ability to quantify a materials engineering problem through numericalanalysis.	K4
CO5	Select materials for specific applications and also to design advanced materials for newapplications.	K3
CO6	To use preferred tools at electronic, continuum and structural levels.	K2

KL – Bloom's Knowledge Level (K_1, K_2, K_3, K_4, K_5, K_6)
K_1- Remember, K_2 – Understand, K_3 – Apply, K_4 – Analyze, K_5- Evaluate, K_6 – Create

Course Articulation Matrix: (Mapping of COs with POs & PSOs)

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3			3				2	1			
CO2	2				1		1	3	3			
CO3	3		2	3				1	1			
CO4												
CO5												
CO6												
CO Average	2.66		2	3	1		1	2	1.66			

3 -High; 2-Medium; 1–Low

Text Books:

1. Introduction to Computational Materials Science – Richard Lesar, Cambridge University Press publishers, 2013
2. Applied Numerical Methods for Engineers using MATLAB and C - Robert J. Schilling & Sandra L.Harris, Cengage Learning (2007).

Reference Books:

1. Mathematical Methods for Physics and Engineering, 3rd Edition – K.F. Riley, M.P. Hobson and S.J. Bence, Cambridge University Press, 2006.
2. Modeling in Materials Processing – Jonathan A. Dantzig, Charles L. Tucker III, Cambridge University Press Publishers, 2001.
3. Materials Science and Engineering, 5th edition - V Raghavan, published by Prentice-Hall India s, 2004.
4. Advanced Engineering Mathematics, 10th edition - Erwin Kreyszig, Published by Wiley, 2010.

5. Modelling of Steel Making Processes, 1st Edition, - Dipak Mazumdar, James W. Evans, Published by CRC Press, 2010.
6. An Introduction to Computational Fluid Dynamics, 2nd edition - H.K.Versteeg , W. Malalsekera, Pearson Education Limited, 2007.
7. Numerical Methods for Engineers, 7th Edition - Steven C. Chapra and Raymond P. Canale, published by Mc Graw Hill Education, 2015.
8. Handbook of Materials Modelling, 2nd edition, Wanda Andreoni and Sidney Yip published by Springer, 2020.
9. Numerical Methods for Engineers, 4th edition - Santosh K. Gupta, New Age International publishers, New Delhi, 2019.

CORROSION PROCESS AND CONTROL

(Open Elective)

Subject Code: -	Open Elective	IA Marks	40
Number of Lecture Hours/Week: -	03	Term End Exam Marks	60
Total Number of Lecture Hours: -	45	CREDITS	03

Course Objectives:

1. To list out various atmospheres responsible for corrosion and understand the various corrosion combating techniques.
2. To determine corrosion rate/ resistance of metals and alloys.
3. To demonstrate electrometallurgy principles in deposition winning and the efficiency of the bath.
4. To explain corrosion protection methods and tests.

Module -1

Introduction, Electro Chemistry principles, Corrosion, Introduction and Definition, electrochemical reactions, Polarization, passivity, environmental effects (oxygen, oxidizers, velocity, temperature, corrosive concentration, Galvanic coupling).

Module -2

Forms of corrosion, uniform corrosion, two metal corrosion: Sacrificial anode, EMF and Galvanic Series, Environmental effects, Pitting corrosion: Pit shape and growth, Autocatalytic Nature of pitting, Crevice corrosion.

Module -3

Intergranular corrosion: Sensitization, weld decay, Knife-Line attack, Stress corrosion cracking: crack morphology, stress effects, environmental factors, metallurgical factors, Erosion corrosion: cavitation damage, fretting corrosion, Corrosion fatigue.

Module -4

Corrosion prevention methods: Alteration of Environment (Inhibitors), Design, Coatings, cathodic and anodic protection. Material selection, Metallurgical aspects, Hydrogen damage (hydrogen blistering, Hydrogen embrittlement, Prevention).

Module -5

Modern theory and applications of corrosion: Introduction, free energy, cell potentials, emf series, applications of thermodynamics to corrosion, Corrosion rate expressions and measurements, corrosion testing.

Course Outcomes:

At the end of the course the student will be able to:

CO1. Able to interpret electro chemical phenomenon.

CO2. Can explain different types of corrosion, their causes, effect and able to identify the different remedial measures to be taken.

CO3. Able to design corrosion resistant structures and materials.

CO4. Determine the thermodynamic causes of corrosion.

CO5. Conduct corrosion tests and able to quantify the corrosion processes.

CO6. Able to graphically represent and interpret Eh-pH, Pourbaix extrapolation techniques.

Course Outcome No	Statement	Knowledge Level (KL)
CO1	Able to interpret electro chemical phenomenon.	K1
CO2	Can explain different types of corrosion, their causes, effect and able to identify thedifferent remedial measures to be taken.	K3
CO3	Able to design corrosion resistant structures and materials.	K1
CO4	Determine the thermodynamic causes of corrosion.	K4
CO5	Conduct corrosion tests and able to quantify the corrosion processes.	K3
CO6	Able to graphically represent and interpret Eh-pH, pourbiax extrapolation techniques.	K3

KL – Bloom's Knowledge Level (K_1, K_2, K_3, K_4, K_5, K_6)

K_1- Remember, K_2 – Understand, K_3 – Apply, K_4 – Analyze, K_5- Evaluate, K_6 – Create

Course Articulation Matrix: (Mapping of COs with POs & PSOs)

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3			3				2	1			
CO2	2				1		1	3	3			
CO3	3		2	3				1	1			
CO4												
CO5												
CO6												
CO Average	2.66		2	3	1		1	2	1.66			

3 - High; 2 - Medium; 1 – Low

Text Books:

1. Corrosion Engineering, M. G. Fontana, 3rd edition, McGraw-Hill, 1985.
2. Corrosion and Corrosion Control, H. H. Uhlig, Wiley, 1985.

Reference Books:

1. Theory of Corrosion and Protection of Metals, N. D. Tomashov, Macmillan, 1967.
2. Introduction to Electrometallurgy & Corrosion by Sharan – Narayan.
3. Corrosion Engineering 1st Edition Principles and Solved Problems by Branko Popov.
4. Handbook of Corrosion Engineering, Second Edition by: Pierre R. Roberge, Ph.D.

ENVIRONMENTAL DEGRADATION OF MATERIALS

Subject Code: -	**Professional Elective**	IA Marks	40
Number of Lecture Hours/Week:-	04	Term End Exam Marks	60
Total Number of Lecture Hours: -	60	CREDITS	04

Pre-Requisites: Engineering Chemistry, Thermodynamics and Kinetics and Principles of Extractive Metallurgy.

Course Objectives:

1. Electrometallurgy principles in deposition winning and the efficiency of the bath to be discussed.
2. Testing methods are to be studied. Various ways in which corrosion takes place in metals/alloys together with corrosion protection methods and tests conducted are to be studied.
3. Able to use principles to understand, the prevention of corrosion.

Module -1 (15 hours)

Electro chemical principles, Nernst equation, electrode potentials, Faradays laws. Polarization, passivity, environmental effects (oxygen, oxidizers, velocity, temperature, corrosive concentration, Galvanic coupling).

Module -2 (10 hours)

Forms of corrosion, uniform corrosion, galvanic corrosion, EMF and Galvanic Series, Pitting corrosion, Crevice corrosion. Intergranular corrosion.

Module -3 (10 hours)

Stress corrosion cracking: crack morphology, stress effects, environmental factors, metallurgical factors, Erosion corrosion: cavitation damage, fretting corrosion, hot corrosion.

Module -4 (15 hours)

Corrosion prevention methods: Alteration of Environment (Inhibitors), Design, Coatings, cathodic and anodic protection. Material selection, Metallurgical aspects, Hydrogen damage (hydrogen blistering, Hydrogen embrittlement, Prevention), Electroplating.

Module -5 (10 hours)

Corrosion testing methods: Immersion technique, Linear polarization, salt spray method, and Corrosion rate calculations.

Course Outcomes:

At the end of the course the student will be able to:

CO1. Outline the electrochemistry of the corrosion process.

CO2. Identify and analyze the "Eight Forms of Corrosion".

CO3. Describe the effects of specific corrosion environments prevailing in the oil and gas industry.

CO4. Select appropriate corrosion monitoring and control techniques.

CO5. To design for corrosion protection, minimization.

CO6. Review and select appropriate materials for corrosion resistant applications.

Course Outcome No	Statement	Knowledge Level (KL)
CO1	Outline the electrochemistry of the corrosion process.	K1
CO2	Identify and analyze the "Eight Forms of Corrosion".	K3
CO3	Describe the effects of specific corrosion environments prevailing in the oil and gasindustry.	K1
CO4	Select appropriate corrosion monitoring and control techniques.	K4
CO5	To design for corrosion protection, minimization.	K3
CO6	Review and select appropriate materials for corrosion resistant applications.	K2

KL – Bloom's Knowledge Level (K_1, K_2, K_3, K_4, K_5, K_6)
K_1- Remember, K_2 – Understand, K_3 – Apply, K_4 – Analyze, K_5- Evaluate, K_6 – Create

Course Articulation Matrix: (Mapping of COs with POs & PSOs)

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3			3				2	1			
CO2	2				1		1	3	3			
CO3	3		2	3				1	1			
CO4												
CO5												
CO6												
CO Average	2.66		2	3	1		1	2	1.66			

3 - High; 2- Medium; 1– Low

Text Books:

1. Corrosion Engineering, 3rd Edition – Mars Fontana, published by McGraw Hill Education, 2017.
2. Electrometallurgy – William Blum.

Reference Books:

1. An Introduction to Electrometallurgy & Corrosion - Dr. R. Sharan and Satya Narain published by Standard Publishers Distributors, 2017.
2. Corrosion Engineering: Principles and Solved Problems, 1st Edition - Branko N. Popov published by Elsevier, 2015

3. Handbook of Corrosion Engineering, 2nd Edition - Pierre R. Roberge, published by McGraw-Hill Education, 2012.

ENVIRONMENTAL DEGRADATION OF MATERIALS LAB

Course Objectives:

1. This lab course is designed to conduct the experiments on electro deposition, verification of Faraday's laws and evaluation of factors affecting on corrosion.
2. To provide understanding of basic electro kinetics.
3. To provide basic knowledge on current efficiency for various electrolytes and electro metallurgy processes.

List of Experiments:

1. EMF series
2. Electroplating of copper.
3. Anodizing.
4. Electroplating of Nickel.
5. Electroplating of chromium.
6. Electroplating of Zinc.
7. Galvanic corrosion.
8. Pitting corrosion.
9. Uniform corrosion acid environments.
10. Uniform corrosion basic environments.
11. Corrosion rate measurement in acid environments.
12. Corrosion rate measurements in basic environment.

Course Outcomes:

Through this laboratory practice, the student will be able:

1. To judge the process variables like current efficiency, current density.
2. To obtain desired electro deposition.
3. Hands on experience on equipment designed for evaluation of corrosion studies.

ENGINEERING PROJECT-2

Subject Code: - BTMT705P	**IA Marks 40**
Number of Lecture Hours/Week: -	**Term End Exam Marks 60**
Total Number of Lecture Hours: -	**CREDITS 05**

Course Objective:

Following are the intended objectives of the Project work:

1. To prepare students to use applications of the theory and practical learned during the course.
2. To help students to develop an industry or research-oriented project.
3. To help students how to carry out project/studies in the field of interest of the student or as given by the industry

Assessment Plan:

Criteria	Description	Maximum Marks
Internal Assessment (IA)	Internal Examination	40
Terminal Examination (TE)	Terminal Examination	60
Total		100
Attendance	A minimum of 75% Attendance is required to be maintained by a student to be qualified for taking up the End Semester examination. The allowance of 25% includes all types of leaves including Medical leaves.	

GUIDELINES FOR PROJECT WORK

The Project work should be based on real/ live problems of the Industry/Govt./NGO/ MSME/Rural Sector or an innovative idea having the potential of a Startup and this project to be carried over to next semester.

SUMMER INDUSTRIAL TRAINING

Subject Code: - BTEEC706P	**IA Marks**
Number of Lecture Hours/Week: -	**Term End Exam Marks**
Total Number of Lecture Hours: -	**CREDITS 02**

Course Objective:

Following are the intended objectives of the Project work:

1. Will expose technical students to the industrial environment, which cannot be simulated in the classroom and hence creating competent professionals for the industry.
2. Provide possible opportunities to learn understand and sharpen the real time technical / managerial skills required at the job.
3. Exposure to the current technological developments relevant to the subject area of training.
4. Experience gained from the „Industrial Internship" in classroom will be use in classroom discussions.
5. Create conditions conducive to quest for knowledge and its applicability on the job

GUIDELINES FOR INTERNSHIP

Summer Internship –II should be undertaken in an industry only

S.No.	Suggested Schedule	Suggested Duration (In weeks)	Activities
1	Summer/winter vacation after 4th Semester	4-6	Inter/Intra Institutional Activities

SEMESTER-VIII

PROFESSIONAL ELECTIVE COURSES

BIO MATERIALS

Subject Code:	Professional Elective	IA Marks	40
Number of Lecture Hours/Week: -	03	Term End Exam Marks	60
Total Number of Lecture Hours: -	45	CREDITS	03

Course Objectives:

1. To introduce the student to the range of biomaterials and the science and engineering of biomaterials.
2. To understand constraints associated with the use of biomaterials.
3. To study various real time applications of bio materials.

Module -1

Introduction to basic concepts of Materials Science, Salient properties of important material classes. Property requirement of biomaterials. Concept of biocompatibility. Structure and properties of biological cells & tissues. Cell-material interactions and foreign body response.

Module -2

Assessment of biocompatibility of biomaterials. In vitro biochemical assays (cellular adhesion, cellular viability using MTT, osteogenic differentiation using ALP assay; Biomnuneralisation using Osteocalcin assay). In vivo testing and histocompatibility assessment. Genotoxicity assessment (Physical damage to DNA by biomaterial eluates).

Module -3

Important bio-metallic alloys: Ti-based, stainless steels, Co-Cr-Mo alloys. Bio-inert, Bioactive and bioresorbable ceramics. Biocompatibility of Alumina & Carbon Nanotube Reinforced Hydroxyapatite. Glass -ceramics for dental restoration applications.

Module -4

Processing and properties of different bio-ceramic materials with emphasize on hydroxyapatite. Synthesis of biocompatible coatings on structural implant materials. Plasma spraying of carbon nanotube reinforced hydroxyapatite on Ti-6Al-4V substrate, in-vitro cytocompatibility. Microstructure and properties of glass-ceramics. Biodegradable polymers.

Module -5

External field and cell – material interaction, Tissue Engineering and Wound healing. Design concept of developing new materials for bio-implant applications.

Course Outcomes:

At the end of the course the student will be able to:

CO1. Explain the types of biomaterials and their relative advantages and disadvantages.

CO2. Indicate the constraints placed on the use of materials in biological environments.

CO3. Explain the characterization of materials from the perspective of application as a biomaterial.

CO4. Explain the factors affecting the bio compatibility of materials.

CO5. Develop and design new advanced materials.

CO6. Develop biodegradable materials for sensitive applications.

Course Outcome No	Statement	Knowledge Level (KL)
CO1	Explain the types of biomaterials and their relative advantages and disadvantages.	K1
CO2	Indicate the constraints placed on the use of materials in biological environments.	K3
CO3	Explain the characterization of materials from the perspective of application as abiomaterial.	K1
CO4	Explain the factors affecting the bio compatibility of materials.	K4
CO5	Develop and design new advanced materials.	K3
CO6	Develop biodegradable materials for sensitive applications.	K3

KL – Bloom's Knowledge Level (K_1, K_2, K_3, K_4, K_5, K_6)
K_1- Remember, K_2 – Understand, K_3 – Apply, K_4 – Analyze, K_5- Evaluate, K_6 – Create

Course Articulation Matrix: (Mapping of COs with POs & PSOs)

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3			3				2	1			
CO2	2				1		1	3	3			
CO3	3		2	3				1	1			
CO4												
CO5												
CO6												
CO Average	2.66		2	3	1		1	2	1.66			

3- High; 2- Medium; 1–Low

Text Books:

1. Introduction to Biomaterials: Basic Theory with Engineering Applications, 1st Edition - C. Mauli Agrawal, Joo L. Ong, Mark R. Appleford and Gopinath Mani, published by Cambridge University Press, 2013.
2. Biomaterials Science: An introduction to Materials in Medicine, 3rd Edition - Edited by Buddy D. Ratner, Allan S. Hoffman, Frederick J. Schoen and Jack E. Lemons - Academic Press, 2012.

Reference Books:

1. Comprehensive Structural Integrity, Vol.9: Bioengineering Editors: Mithe, Ritchie and Karihalo, Elsevier Academic Press, 2003.

2. Biomaterials Science and Biocompatibility, 1st Edition - Fredrick H. Silver and David L. Christiansen, published by Springer, 2012.
3. Biological Performance of Materials: Fundamentals of Biocompatibility, 3rd Edition - Jonathan Black, published by Marcel Dekker, Inc., 1992.
4. Basic Cell Culture: A Practical Approach - Edited by J.M. Davis, published by Oxford University Press, 1995.

ELECTRONIC MATERIALS
(Professional Elective)

Subject Code: -	**Professional Elective**	IA Marks	40
Number of Lecture Hours/Week: -	03	Term End Exam Marks	60
Total Number of Lecture Hours: -	45	CREDITS	03

Pre- Requisites: Nil

Course Objectives:

1. To become familiar with the science, synthesis, evaluation, and applications of electronic materials.
2. To know the manufacturing processes associated with use of electronic materials for devices.

Module -1

Electronic structure and its relevance in crystalline materials: Review of quantum mechanics: Electron as waves and particles; Wave-function; Electron as a plane-wave, Operators; Schrodinger Equation, Wave-vector (k); Energy of free-electron as a function of wave-vector k (ε - k diagram, a parabola), k-space; Density-of states [g(ε)]; Fermi-sphere, -energy, -surface, -temperature, and – velocity. Electrons in a solid following Fermi-Dirac distribution; DC conductivity in metals. Lattice; Bravais-Lattice; Wigner-Seitz cell; k-space: Reciprocal space; Reciprocal lattice and it's connection to its direct-lattice, Brillouin zone; Von-Lau condition of Bragg diffraction and boundaries of Brillouin-zone being the Bragg-Planes Electrons in a periodic-potential; Bloch Theorem, Kronig-Penny model; Origin of energy bands and band-gap; Free electron band diagram, Extended-, Periodic and reduced-zone representation for ε - k diagram; Allowed number of states in a band.

Module -2

Electron Dynamics: Group-velocity, electron dynamics from ε - k diagram and the concept of effective-mass and concept of holes; Conductivity in relation to band structure; Band structure of metals and semiconductors, and insulators; Band-overlap: why some metals show positive charge carriers in Hall-effect.

Module -3

Semiconductors and Magnetic Materials: Band diagrams, direct and indirect bandgap, applications of semiconductors; Effective-mass of electron in conduction-band and that of hole in valence-band Intrinsic semiconductors: Fermi-level; Density-of-states near the edges of conduction and valence-band; Fermi-dirac statistics approximated by Maxwell-Boltzman; Intrinsic charge-carrier concentration, Law-of mass-action; Direct vs Indirect Semiconductors,

Extrinsic-semiconductor: Hydrogen-model for rough estimate of the donor and acceptor energy level, n- and p-type semiconductors; Population of impurity levels in thermal equilibrium, charge-carrier concentration in n- and p- type semiconductors; Fermi-level, Degenerate and non-degenerate semiconductors, determination of dopant levels and mobility measurements Semiconductor Devices: p-n junction and solar cells; Bandgap engineering: Solid-state LEDs, Lasers and IR detectors. Orbital and spin - permanent magnetic moment of atoms, diamagnetism, paramagnetism, and Pauli-paramagnetism, Ferro, anti-ferro and ferri magnetism, Fe, Co and Ni and alloy additions, ferrites, magnetic hysteresis, exchange energy, magnetocrystalline energy, magnetorestriction; Highly correlated systems. Applications: Spintronics and memory devices Superconductors, Multiferroic materials.

Module -4

Ionic conductors and Dielectric materials: Ionic conduction – review of defect equilibrium and diffusion mechanisms; Theory of ionic conduction, conduction in glasses; Effect of stoichiometric and extrinsic defects on conduction, Applications in sensors and fuel cells.
Dielectric constants and polarization, linear dielectric materials, capacitors; Polarization mechanisms; Non-linear dielectrics, pyro-, piezo-, and ferro-electric properties, hysterisis and ferroelectric domains; Applications in sensors, actuators and memory devices.

Module -5

Manufacturing of Electronic Materials: Introduction to semiconductor manufacturing. History, overview of process flow, manufacturing goals. Scaling. Wafer manufacturing. Si ingot preparation. Poly to single crystal conversion. Czochralski vs. float zone method. IC device manufacturing overview. Thermal oxidation. Doping. Lithography. Etching and growth. Metallization and growth.

Course Outcomes:

At the end of the course the student will be able to:

CO1. Indicate and explain important scientific parameters associated with electronic materials.
CO2. Describe different semiconductors and their properties with examples.
CO3. Explain the features and functioning of several electronic devices.
CO4. Describe the manufacturing processes associated with electronic materials and devices.
CO5. Use simple band diagrams to understand the optical activity of a semiconductor.

Course Outcome No	Statement	Knowledge Level (KL)
CO1	Indicate and explain important scientific parameters associated with electronic materials.	K1
CO2	Describe different semiconductors and their properties with examples.	K3
CO3	Explain the features and functioning of several electronic devices.	K1
CO4	Describe the manufacturing processes associated with electronic materials and devices.	K4
CO5	Use simple band diagrams to understand the optical activity of a semiconductor.	K3

KL – Bloom's Knowledge Level (K_1, K_2, K_3, K_4, K_5, K_6)
K_1- Remember, K_2 – Understand, K_3 – Apply, K_4 – Analyze, K_5- Evaluate, K_6 – Create

Course Articulation Matrix: (Mapping of COs with POs & PSOs)

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3			3				2	1			
CO2	2				1		1	3	3			
CO3	3		2	3				1	1			
CO4												
CO5												
CO Average	2.66		2	3	1		1	2	1.66			

3 -High; 2 - Medium; 1 –Low

Text Books:

1. Electronic Properties of Materials: An Introduction for Engineers, Rolf E. Hummel, Springer Verlag, 1985
2. Physical Properties of Semiconductors, Charles M. Wolfe, Nick Holonyak and Gregory E. Stillman, Prentice Hall, 1989
3. Semiconductor Materials, Devices and Fabrication, Parasuraman Swaminathan, Wiley 2017

Reference Books:

1. Principles of Electronic Materials and Devices, S. O. Kasap, McGraw Hill Education, 2017.
2. Electronic Materials by Chelikowsky, James R., Franciosi, Alfonso (Eds.).
3. Electronic Materials and Processes Handbook by Charles Harper.

HIGH TEMPERATURE MATERIALS

Subject Code:	Professional Elective	IA Marks	40
Number of Lecture Hours/Week: -	03	Term End Exam Marks	60
Total Number of Lecture Hours: -	45	CREDITS	03

Course objectives:

1. To learn and design material's microstructure for high temperature applications.
2. To learn scientific issues related to high temperature such as creep, oxidation and material degradation.
3. To study the properties which improve high temperature resistance.

Module -1

Creep, Types of Creep, Testing methods, Creep data presentation, Creep Curve and stages of creep, Mechanisms of Creep and creep resistant steels.

Module -2

Fatigue, thermal fatigue, ageing, structural changes, material damage, crack propagation, damage mechanics, life time analysis, Creep-Fatigue interaction.

Module -3

Oxidation, Kinetics of oxidation, Factors controlling oxidation, Hot Corrosion, Testingmethods, Mechanisms of hot corrosion, erosion, Hot corrosion properties of carbon steels and stainless steels.

Module -4

Super alloys: their processing, high temperature mechanical properties, Corrosion behaviour, Ceramics for applications in refractory technology, Properties and applications of high temperature polymers.

Module -5

Refractory metals and alloys, Intermetallics, Carbon-Carbon composites, Ceramic matrix composites for refractory applications, Industrial, defence and nuclear applications.

Text Books:

1. Creep of metals and alloys - Evans, R.W and Wilshire, B., Institute of metals, London, 1985.
2. Heat- resistant materials - J.R. Davis, ASM Specialty Handbook: ASM, 1997.

Course Outcomes:

At the end of the course the student will be able to:

CO1. Outline the different processes responsible for failure of materials at high temperature.

CO2. Able to relate the causes for creep failure and choice of creep resistant materials.

CO3. Able to interpret the structural changes taking place during fatigue and aging and carry out analysis of data.

CO4. Able to interpret the chemical causes for failure at high temperature.

CO5. Distinguish the role of ceramics, polymers, super alloys etc., at high temperature.

CO6. Analysis of data available for design and improve the existing materials.

Course Outcome No	Statement	Knowledge Level (KL)
CO1	Outline the different processes responsible for failure of materials at high temperature.	K1
CO2	Able to relate the causes for creep failure and choice of creep resistant materials.	K3
CO3	Able to interpret the structural changes taking place during fatigue and aging and carryout analysis of data.	K1
CO4	Able to interpret the chemical causes for failure at high temperature.	K4
CO5	Distinguish the role of ceramics, polymers, super alloys etc., at high temperature.	K3
CO6	Analysis of data available for design and improve the existing materials.	K3

KL – Bloom's Knowledge Level (K_1, K_2, K_3, K_4, K_5, K_6)
K_1- Remember, K_2 – Understand, K_3 – Apply, K_4 – Analyze, K_5- Evaluate, K_6 – Create

Course Articulation Matrix: (Mapping of COs with POs & PSOs)

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3			3				2	1			
CO2	2				1		1	3	3			
CO3	3		2	3				1	1			
CO4												
CO5												
CO6												
CO Average	2.66		2	3	1		1	2	1.66			

3 - High; 2 - Medium; 1 – Low

Reference Books:

1. Introduction to the High Temperature Oxidation of Metals - Neil Birks, Gerald H. Meier, and Frederick S. Pettit, 2009.
2. The Super-alloys: Fundamentals and Applications, 1st edition - Roger C. Reed, Cambridge University Press, 2008.
3. High Temperature Coatings, 1st edition - Sudhansu Bose, Published by Butterworth-Heinemann, 2007.
4. Polyimides and Other High Temperature Polymers: Synthesis, Characterization and Applications - K. L. Mittal, Brill Academic Publications, 2009.

SOLIDIFICATION PROCESSING

Subject Code: -	**Professional Elective**	IA Marks	40
Number of Lecture Hours/Week: -	03	Term End Exam Marks	60
Total Number of Lecture Hours: -	45	CREDITS	03

Pre-Requisites: Physical Metallurgy and Material Processing-I

Course Objectives :

1. To inculcate the metallurgical aspects during solidification of metal and alloys.
2. To impart knowledge about solidification of casting with detail emphasis on calculation of gating/riser system.
3. To impart knowledge about solidification behaviour during welding and effect of microstructure in HAZ.

Module -1

Principles of solidification: Nucleation and growth of pure metals and alloys, Cooling curves,heat transfer associated in nucleation and growth, eutectic solidification; Homogeneous and Heterogeneous nucleation.

Module -2

Solidification of ingots and castings: formation of plane front columnar, equiaxed and dendritic structures, Effect of composition, moulding materials and cooling rate on solidification pattern.

Module -3

Segregation and shrinkage phenomena in castings, calculation of solidification time for casting,heat transfer calculations in metal casting, principles of chill design.

Module -4

Heat transfer in weldments, dissipation of welding heat, cooling rates, weld metal cooling curves, peak temperature, calculating width of heat affected zones, solidification rate and effects of heat input.

Module -5

Heat conduction with and without phase change by finite element method, finite volume method and finite differences methods.

Course Outcomes:

At the end of the course the student will be able to:

CO1. Explain the principles and practice of directional solidification.

CO2. Describe the procedures used for controlling porosity and shrinkage during solidification processing.

CO3. List out the microstructural differences between cast and wrought metallic alloy products.

CO4. Knowledge about the microstructural mechanisms associated with metals joining operations including heat affected zones.

CO5. Explain the principles and practice of directional solidification.

CO6. Describe the procedures used for controlling porosity and shrinkage during solidification processing.

Course Outcome No	Statement	Knowledge Level (KL)
CO1	Explain the principles and practice of directional solidification.	K1
CO2	Describe the procedures used for controlling porosity and shrinkage during solidificationprocessing.	K3
CO3	List out the microstructural differences between cast and wrought metallic alloy products.	K1
CO4	Knowledge about the microstructural mechanisms associated with metals joiningoperations including heat affected zones.	K4
CO5	Explain the principles and practice of directional solidification.	K3
CO6	Describe the procedures used for controlling porosity and shrinkage during solidificationprocessing.	K3

KL – Bloom's Knowledge Level (K_1, K_2, K_3, K_4, K_5, K_6)

K_1- Remember, K_2 – Understand, K_3 – Apply, K_4 – Analyze, K_5- Evaluate, K_6 – Create

Course Articulation Matrix: (Mapping of COs with POs & PSOs)

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3			3				2	1			
CO2	2				1		1	3	3			
CO3	3		2	3				1	1			
CO4												
CO5												
CO6												
CO Average	2.66		2	3	1		1	2	1.66			

3-High; 2- Medium; 1–Low

Text Books:

1. Physics of Welding – J. F. Lancaster, Pergamon press, 1986.
2. Principles of Metal Casting, 2nd Edition - Richard W. Heine, Carl R. Loper, Philip C. Rosenthal, published by McGraw Hill Higher Education1976.

Reference Books:

1. Fundamentals of Solidification, 4th Edition - W. Kurz and D.J. Fisher, published by CRC Press, 1998.
2. Castings, 2nd Edition - John Campbell, published by Butterworth Heinemann, 2003.
3. Science and Engineering of Casting Solification, 2nd Edition - Doru Micheal stefanescu, published by Springer, 2009.
4. Solidification and Casting - Davies, Graeme John, Applied science publishers Ltd., 1973
5. Solidification Processing - M.C. Flemings, McGraw-Hill, N.Y., 1974
6. Solidification of Casting; Ruddle, R.W., Institute of Metals, 1957

NON METALLIC MATERIALS

Subject Code: -	**Professional Elective**	IA Marks	40
Number of Lecture Hours/Week: -	03	Term End Exam Marks	60
Total Number of Lecture Hours: -	45	CREDITS	03

Pre-Requisites: Nil

Course Objectives:

1. To introduce the student to the range of non-metallic materials available for engineering.
2. To understand the classification and significance of nonmetallic materials to apply them in Industries.
3. To get an exposure to the techniques associated with the synthesis, processing and characterization of these materials.
4. To become aware of the applications where these materials are preferred.

Module -1

Definition and classification of materials, comparison of properties of metals and nonmetallic

materials. Nature of bonding.

Module -2

Ceramics: Structure, defects. Ionic and semiconducting behavior. Processing techniques. Glasses and glass-ceramics, glass fibres. Structural ceramics: fracture toughness, toughening mechanisms. Special ceramics: Electro-optic, dielectric, ferroelectric, piezoelectric, magnetic, superconducting, laser and dilute magnetic and bio-ceramics.

Module -3

Polymers: Structure, properties and applications of thermoplastics and thermosets. Conducting and biopolymers.

Module -4

Composites: Introduction, classification, and applications of composite materials. Manufacturing of Polymer matrix, metal matrix, and ceramic matrix composites.

Module -5

Textiles. Adhesives, and Foams: Introduction, classification and applications of textile materials. Structure of Adhesives and their applications. Classification and applications of foam materials, Manufacturing methods of industrially important adhesives and foams.

Course Outcomes:

At the end of the course the student will be able to:

CO1. List the prominent non-metallic materials available for engineering applications.
CO2. Indicate the synthesis and processing steps associated with non-metallic materials.
CO3. Indicate the structure property relations in non-metallic materials.
CO4. Understand the behavior of each non-metallic material in detail.
CO5. Indicate the uses for which non-metallic materials are preferred.
CO6. Explain the manufacturing methods of industrially important adhesives and foams.

Course Outcome No	Statement	Knowledge Level (KL)
CO1	List the prominent non-metallic materials available for engineering applications.	K1
CO2	Indicate the synthesis and processing steps associated with non-metallic materials.	K3
CO3	Indicate the structure property relations in non-metallic materials.	K1
CO4	Understand the behavior of each non-metallic material in detail.	K4
CO5	Indicate the uses for which non-metallic materials are preferred.	K3
CO6	Explain the manufacturing methods of industrially important adhesives and foams.	K3

KL – Bloom's Knowledge Level (K_1, K_2, K_3, K_4, K_5, K_6)
K_1- Remember, K_2 – Understand, K_3 – Apply, K_4 – Analyze, K_5- Evaluate, K_6 – Create

Course Articulation Matrix: (Mapping of COs with POs & PSOs)

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3			3				2	1			
CO2	2				1		1	3	3			
CO3	3		2	3				1	1			
CO4												
CO5												
CO6												
CO Average	2.66		2	3	1		1	2	1.66			

3 - High; 2 - Medium; 1 – Low

Text Books:

1. Textbook of Polymer Science 3rd Edition - Fred W. Billmeyer, Published by Wiley 2007.
2. Introduction to Ceramics, 2nd Edition - W. David Kingery, H.K. Bowen, Donald R. Uhlmann, published by Wiley India Pvt Limited, 2012.

Reference Books:

1. Composite Materials: Science and Engineering, 4th Edition - Krishan K. Chawla, Springer, 2019.
2. Principles of Materials Science and Engineering, 3rd Edition - William Smith, Published by McGraw-Hill Education, 1995.
3. Materials Science and Engineering, 6th Edition - V. Raghavan, published by Prentice Hall India Learning Private Limited, 2015.

FUNCTIONAL MATERIALS

Subject Code: -	**Professional Elective**	IA Marks	40
Number of Lecture Hours/Week: -	03	Term End Exam Marks	60
Total Number of Lecture Hours: -	45	CREDITS	03

Pre-Requisites: Nil

Course Objectives:

1. To introduce the student to functional materials and the science behind the performance of the functional materials.
2. To enable the student to understand the applications of functional materials.
3. To study about semiconductors, dielectrics, Piezo, Ferro electric and smart materials.

Module -1

Characteristics and types of functional materials. Crystal structure and Properties. Effect of size on properties, effect of interfaces on properties. Magnetic materials and storage applications.

Module -2

High Temperature Behaviour of Amorphous and Nanocrystalline Soft Magnetic Materials Magnetic storage devices store data using a combination of magnetic fields and binary data,

Band structure, Semiconductor devices – Theory, examples and applications of Optically active materials.

Module -3

Basics of semiconductor electrical properties, operation of the semiconductor devices. Eg: Band structure, Diode, MOS device capacitor, MOS transistor structure and operation, Transistor formation and Transistor isolation.

Module -4

Dielectrics, Piezo and ferroelectric materials: Introduction, properties, applications. Recent developments in advanced dielectric, piezoelectric and ferroelectric materials. High strain high performance piezo- and ferroelectric single crystals; Electric field-induced effects and domain engineering; Morphotropic phase boundary related phenomena; High power piezoelectric and microwave dielectric materials; Nanoscale piezo- and ferroelectrics.

Module -5

Smart materials: Introduction, definition, applications, factors affecting properties of smart materials. Applications in electronic, communication, aerospace, automotive, energy industries.

Course Outcomes:

At the end of the course the student will be able to:

CO1. Indicate the various types of functional materials.

CO2. Explain the principle of operation of the functional materials.

CO3. Indicate the applications of the functional materials.

CO4. Judge the factors that affect the interface and size on the properties of functional materials.

CO5. Identify the applications of functional materials in advance and modern systems.

CO6. Indicate the various types of functional materials.

Course Outcome No	Statement	Knowledge Level (KL)
CO1	Indicate the various types of functional materials.	K1
CO2	Explain the principle of operation of the functional materials.	K3
CO3	Indicate the applications of the functional materials.	K1
CO4	Judge the factors that affect the interface and size on the properties of functional materials.	K4
CO5	Identify the applications of functional materials in advance and modern systems.	K3
CO6	Indicate the various types of functional materials.	K3

KL – Bloom's Knowledge Level (K_1, K_2, K_3, K_4, K_5, K_6)

K_1- Remember, K_2 – Understand, K_3 – Apply, K_4 – Analyze, K_5- Evaluate, K_6 – Create

Course Articulation Matrix: (Mapping of COs with POs & PSOs)

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3			3				2	1			
CO2	2				1		1	3	3			
CO3	3		2	3				1	1			
CO4												
CO5												
CO6												
CO Average	2.66		2	3	1		1	2	1.66			

3 - High; 2 - Medium; 1 – Low

Text Books:

1. Functional Materials: Electrical, Dielectric, Electromagnetic, Optical and Magnetic applications, - Deborah D L Chung, World Scientific Publishing, 2010.
2. Advanced Functional Materials (Advanced Material Series), 1st Edition – Ashutosh Tiwari, Lokman Uzun, published by Wiley-Scrivener, 2015.

Reference Books:

1. Functional Materials: Preparation, Processing and Applications, 1st Edition – by S. Banerjee, A.K.Tyagi, published by Elsevier, 2011.
2. Advanced Functional Materials by Hee – Gweon Woo, Hong Li, published by Springer, 2011.
3. Functional Materials: Properties, Performance and Evaluation, 1st Edition - Ewa Klodzinska published by Apple Academic Press, 2015.

ALLOY STEELS

Subject Code: -	**Professional Elective**	IA Marks	40
Number of Lecture Hours/Week: -	03	Term End Exam Marks	60
Total Number of Lecture Hours: -	45	CREDITS	03

Pre-Requisites: Nil

Course Objectives:

This course deals with:

1. Describe the physical metallurgy of steels and alloy steels.
2. Explain the microstructure and properties of steels and alloy steels.
3. Make judgments on microstructural evolution and properties developed in alloy steels.

Module -1

Classification of Steels. Advantages and limitations of Plain carbon steels. Alloy steels classification, purpose and general effects of alloy elements in steels. Cold forming steels, High strength packing steels; HSLA steels.

Module -2

Medium - High carbon ferrite-pearlite steels, Bainitic steels, Low-carbon bainitic steels requirements, development and choice of alloying elements, Mechanical properties, microstructure and impact properties, High-Carbon bainitic steels.

Module -3

Ultra-high strength steels: Classification and applications. Cryogenic steels, Thermo- mechanical treatments, maraging steels.

Module -4

Stainless steels: Classification, Composition, role of alloying elements, Heat treatment, microstructure and applications. Nitrogen steels and dual phase steels

Module -5

Tool steels and Heat resistant steels: Classification, Composition, role of alloying elements, Heat treatment, microstructure and applications.

Course Outcomes:

At the end of the course the student will be able to:

CO1. Able to classify plain carbon steels, alloy steels and differentiate the steels and appreciate the role of alloy elements in steels and how to modify the structures to get the desired properties in steels.

CO2. Know the importance of structure - property correlation study in HSLA, ultra high strength steels etc.., and their suitable applications.

CO3. Analyze the importance of composition, heat treatment and microstructure effects on properties and uses of stainless steels.

CO4. Analyze the importance of composition, heat treatment and microstructure effects on properties and uses of tool steels and heat-resistant steels.

CO5. Able to apply the knowledge gained on microstructural evolution and its stability to optimize the processing routes for specific applications.

CO6. Able to classify plain carbon steels, alloy steels and differentiate the steels and appreciate the role of alloy elements in steels and how to modify the structures to get the desired properties in steels.

Course Outcome No	Statement	Knowledge Level (KL)
CO1	Able to classify plain carbon steels, alloy steels and differentiate the steels and appreciate the role of alloy elements in steels and how to modify the structures to get the desired properties in steels.	K1
CO2	Know the importance of structure - property correlation study in HSLA, Ultra high strengthsteels etc.., and their suitable applications.	K3
CO3	Analyze the importance of composition, heat treatment and microstructure effects on properties and uses of stainless steels.	K1
CO4	Analyze the importance of composition, heat treatment and microstructure effects on properties and uses of tool steels and heat resistant steels.	K4

CO5	Able to apply the knowledge gained on microstructural evolution and its stability to optimize the processing routes for specific applications.	K3
CO6	Able to classify plain carbon steels, alloy steels and differentiate the steels and appreciate the role of alloy elements in steels and how to modify the structures to get the desired properties in steels.	K3

KL – Bloom's Knowledge Level (K_1, K_2, K_3, K_4, K_5, K_6)
K_1- Remember, K_2 – Understand, K_3 – Apply, K_4 – Analyze, K_5- Evaluate, K_6 – Create

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3			3				2	1			
CO2	2				1		1	3	3			
CO3	3		2	3				1	1			
CO4												
CO5												
CO6												
CO Average	2.66		2	3	1		1	2	1.66			

3 - High; 2 - Medium; 1 – Low

Text Books:

1. Physical Metallurgy and the Design of steels - F. B. Pickering, Applied Science publisher, London, 1978.
2. The physical Metallurgy of steels: William C. Leslie, Hemisphere Publishers Corporation, 1981.

Reference Books:

1. Alloys Steels – Wilson.
2. Heat Treatment of steels, 2nd Edition – Rajan & Sharma, PHI publications, 2011.

RENEWABLE ENERGY ENGINEERING

Subject Code: -	**BTME702-A**	**IA Marks**	**40**
Number of Lecture Hours/Week:-	**03**	**Term End Exam Marks**	**60**
Total Number of Lecture Hours: -	**45**	**CREDITS**	**03**

Course Objective:

1. To acquire knowledge of technical competency combined with research to generate innovative solutions in Energy engineering.
2. To be acquainted with a variety of options in energy sources.
3. To prepare the students to exhibit a high level of professionalism, integrity, environmental and social responsibility, and life-long independent learning ability with environment in mind.

Assessment Plan:

Criteria	Description	Maximum Marks
Internal Assessment (IA)	Internal Examination	30
	Attendance/Discipline	5

	Assignment/ Seminar	5
Terminal Examination (TE)	Terminal Examination	60
Total		100
Attendance	A minimum of 75% Attendance is required to be maintained by a student to be qualified for taking up the End Semester examination. The allowance of 25% includes all types of leaves including medical leaves.	

Course Content:

Module 1

Introduction: Basic concepts of energy; Introduction to Renewable Energy Technologies; Energy and Environment – global warming, acid rains, depletion of ozone layer; Global and Indian Scenario of renewable energy sources; Energy storage - necessity and energy storage methods.

Module 2

Solar Energy: Fundamentals; Solar Radiation; Estimation of solar radiation on horizontal and inclined surfaces; Measurement of solar radiation data. **Solar Thermal Systems:** Introduction; Basics of thermodynamics and heat transfer; Flat plate collector; Evacuated Tubular Collector; Solar air collector; Solar concentrator; Solar distillation; Solar cooker; Solar refrigeration and air conditioning; Thermal energy storage systems. **Solar Photovoltaic Systems:** Introduction; Solar cell Fundamentals; Characteristics and classification; Solar cell: Module, panel and Array construction; Photovoltaic thermal systems.

Module 3

Wind Energy: Introduction; Origin and nature of winds; Wind turbine siting; Basics of fluid mechanics; Wind turbine aerodynamics; wind turbine types and their construction; Wind energy conversion systems.

Module 4

Fuel cells: Overview; Classification of fuel cells; Operating principles; Fuel cell thermodynamics. **Biomass Energy:** Introduction; Photosynthesis Process; Biofuels; Biomass Resources; Biomass conversion technologies; Urban waste to energy conversion; Biomass gasification.

Module 5

Other forms of Energy: Introduction: Nuclear, ocean and geothermal energy applications; Origin and their types; Working principles.

Text /Reference Books:

1. O.P. Gupta, “Energy Technology”, Khanna Book Publishing, New Delhi.
2. V.V.N. Kishore, “Renewable Energy Engineering and Technology: Principles and Practice,” Routledge, 1st Edition, 2019.
3. N. Jenkins and J. Ekanayake, “Renewable Energy Engineering,” Cambridge University Press, 1st Edition, 2017.
4. G. Boyle, “Renewable Energy,” OUP Oxford, 2nd Edition, 2009.

Online Resources:

1. https://onlinecourses.nptel.ac.in/noc22_ph44/preview
2. https://onlinecourses.swayam2.ac.in/nou22_ge71/preview

Course Outcomes:

At the end of this course students will demonstrate the ability to

CO1. Acquire, apply and share in depth knowledge in the area of Energy Engineering and Management.

CO2. An ability to apply engineering and scientific principles for the effective management of energy systems.

CO3. Explain the basic principles of energy conversion processes and devices used therein

CO4. Identify suitable renewable source and technology for a given requirement.

CO5. Undertake field projects in these areas

Course Outcome No	Statement	Knowledge Level (KL)
CO1	Acquire, apply and share in depth knowledge in the area of Energy Engineering and Management.	K_1
CO2	An ability to apply engineering and scientific principles for the effective management of energy systems.	K_2
CO3	Explain the basic principles of energy conversion processes and devices used therein	K_3
CO4	Identify suitable renewable source and technology for a given requirement.	K_2
CO5	Undertake field projects in these areas	K_3

KL- Bloom's Knowledge Level (K_1, K_2, K_3, K_4, K_5, K_6)

K_1-Remember, K_2- Understand, K_3- Apply, K_4- Analyze, K_5- Evaluate, K_6- Create

Course Articulation Matrix: (Mapping of COs with POs & PSOs)

CO	CORRELATION WITH PROGRAM OUTCOMES												CORRELATION WITH PSOs	
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12	PSO1	PSO2
CO1	3						1		1					
CO2		1	2											
CO3				3									1	
CO4														
CO5	2	3		3										
CO(Average)	2.5	2	2	3			1		1				1	

3 –High; 2 –Medium; 1 –Low

ADDITIVE MANUFACTURING

Subject Code: -		**IA Marks**	**40**
Number of Lecture Hours/Week:-	**03**	**Term End Exam Marks**	**60**
Total Number of Lecture Hours: -	**45**	**CREDITS**	**03**

Course Objective:

To provide an overview of Additive Manufacturing processes, systems and applications.

Assessment Plan:

Criteria	Description	Maximum Marks
Internal Assessment (IA)	Internal Examination	30
	Attendance/Discipline	5
	Assignment/ Seminar	5
Terminal Examination (TE)	Terminal Examination	60
Total		100
Attendance	A minimum of 75% Attendance is required to be maintained by a student to be qualified for taking up the End Semester examination. The allowance of 25% includes all types of leaves including medical leaves.	

Course Content:

Module I

Introduction to Additive Manufacturing (AM): Evolution of AM/3D printing; Comparison with subtractive and forming processes; Advantages of AM; Classification of AM processes; Key steps in AM.

Module II

Liquid State-based AM Processes: Stereo lithography – Process and working principle; Photopolymers; Photo polymerization, layering technology, Laser and Laser scanning; Micro-stereolithography; Equipment and specifications; Applications, advantages, disadvantages, examples; Solid ground curing: Process, Working principle; Equipment and specifications; Applications, advantages, disadvantages, examples.

Module III

Solid State-based AM Processes: Fused Deposition Modeling – Process, working principle and materials; Equipment and specifications; Laminated object manufacturing – Process and working principle; Equipment and specifications; Applications, advantages, disadvantages, examples; Other solid-state processes – Ultrasonic consolidation, Gluing, Thermal bonding; Demonstration of equipment.

Module IV

Powder Based AM Processes: Powder Bed Fusion Processes – Working principle and materials; Powder fusion mechanism and powder handling; Various LBF processes (principle, materials, applications and examples) – Selective laser Sintering, Electron Beam Melting, Laser Engineered Net Shaping, Binder Jetting and Direct Metal Deposition; Comparison between LBF processes; Materials-process-structure-property relationships; relative advantages and limitations.

Module V

Applications of AM: Product development lifecycle applications – Rapid prototyping, concept models, visualization aids, replacement parts, tooling, jigs and fixtures, moulds and casting;

Application sectors – aerospace, automobile, medical, jewelry, sports, electronics, food, architecture, construction and others.

Text /Reference Books:

1. Sabrie Soloman, 3D Printing & Design, Khanna Book Publishing Company, New Delhi, 2020.
2. Ian Gibson, David W Rosen, Brent Stucker, "Additive Manufacturing Technologies: 3D Printing, Rapid Prototyping and Direct Digital Manufacturing", Springer, 2015
3. Chua Chee Kai, Leong Kah Fai, "3D Printing and Additive Manufacturing: Principles & Applications," World Scientific, 2015.
4. C.P Paul, A. N Junoop, "Additive Manufacturing: Principles, Technologies and applications," McGraw Hill, 2021.

Online Resources:

1. https://onlinecourses.nptel.ac.in/noc21_me115/preview
2. https://onlinecourses.nptel.ac.in/noc20_mg70/preview

Course Outcomes:

At the end of this course students will demonstrate the ability to

CO1. Understand the overall principle and various processes for additive manufacturing.
CO2. Select a particular additive manufacturing process based on the end application.
CO3. Plan the steps in fabricating a given part using additive manufacturing.

Course Outcome No	Statement	Knowledge Level (KL)
CO1	Understand the overall principle and various processes for additive manufacturing.	K_1
CO2	Select a particular additive manufacturing process based on the end application.	K_2
CO3	Plan the steps in fabricating a given part using additive manufacturing.	K_3

KL- Bloom's Knowledge Level (K_1, K_2, K_3, K_4, K_5, K_6)

K_1-Remember, K_2- Understand, K_3- Apply, K_4- Analyze, K_5- Evaluate, K_6- Create

Course Articulation Matrix: (Mapping of COs with POs & PSOs)

CO	CORRELATION WITH PROGRAM OUTCOMES												CORRELATION WITH PSOs	
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12	PSO1	PSO2
CO1	3						1		1					
CO2		1	2											
CO3				3									1	
CO(Average)	3	1	2	3			1		1				1	

3 –High; 2 –Medium; 1 –Low

GAS DYNAMICS AND JET PROPULSION

Subject Code: -	**Professional Elective**	**IA Marks**	**40**
Numberof Lecture Hours/Week: -	**03**	**Term End Exam Marks**	**60**
Total Number of Lecture Hours: -	**45**	**CREDITS**	**03**

Course Objective:

1. To understand the features of compressible isentropic flows and irreversibility like shocks.
2. To provide a basic knowledge of jet and rocket propulsion technologies.

Assessment Plan:

Criteria	Description	Maximum Marks
Internal Assessment (IA)	Internal Examination	30
	Attendance/Discipline	5
	Assignment/ Seminar	5
Terminal Examination (TE)	Terminal Examination	60
Total		100
Attendance	A minimum of 75% Attendance is required to be maintained by a student to be qualified for taking up the End Semester examination. The allowance of 25% includes all types of leaves including medical leaves.	

Course Content:

Module 1

BASIC CONCEPTS AND ISENTROPIC FLOWS: Energy and momentum equations of compressible fluid flows – Stagnation states. Compressible flow, definition, Mach waves and Mach cone. Isentropic flow through variable area ducts, nozzle s and diffusers. Subsonic and supersonic flow I variable area ducts, choked flow, Area-Mach number relations for isentropic flow.

Module 2

FLOW THROUGH DUCTS: Non-isentropic flow in constant area ducts, Rayleigh and Fanon flows. Variation of flow properties – Use of tables and charts – Generalized gas dynamics.

Module 3

NORMAL AND OBLIQUE SHOCKS: Governing equations, Variation of flow parameters across the normal and oblique shocks. Prandtl – Meyer relations, Use of table and charts – Applications.

Module 4

JET PROPULSION: Theory of jet propulsion, thrust equation thrust power and propulsive efficiency. Operating principle and cycle analysis of ramjet. Turbojet, Turbofan and Turboprop engines.

Module 5

SPACE PROPULSION: Types of rocket engines, propellants & feeding systems, ignition and combustion. Theory of rocket propulsion, performance study. Staging, terminal and characteristic velocity, space flights.

Text /Reference Books:

1. Ahmed F. El-Sayed, Aircraft Propulsion and Gas Turbine Engines, CRC Press, 2008.H.S.
2. Mukunda, "Understanding Aerospace Chemical Propulsion", Interline Publishing, 2004.
3. Hill P. and Peterson C., Mechanics & Thermodynamics of Propulsion, Addison Wesley, 1992.

Reference Books

1. Zucrow N. J., Aircraft and Missile Propulsion, Vol.I& II, John Wiley, 1975.
2. Sutton G.P., Rocket Propulsion Elements, John Wiley, New York, 1986.

Course Outcomes:

At the end of this course students will demonstrate the ability

CO1. Understand the basic difference between incompressible and compressible flow.

CO2. Understand the phenomenon of shock waves and its effect on flow. To gain some basic knowledge about jet propulsion and Rocket Propulsion.

CO3. Upon completion of this course, the students can able to successfully apply gas dynamics principles in the Jet and Space Propulsion.

CO4. Understand the phenomenon of shock waves and its effect on flow. To gain some basic knowledge about jet propulsion and Rocket Propulsion.

CO5. Upon completion of this course, the students can able to successfully apply gas dynamics principles in the Jet and Space Propulsion.

Course Outcome No	Statement	Knowledge Level (KL)
CO1	Understand the basic difference between incompressible and compressible flow.	K_1
CO2	Understand the phenomenon of shock waves and its effect on flow. To gain some basic knowledge about jet propulsion and Rocket Propulsion.	K_2
CO3	Upon completion of this course, the students can able to successfully apply gas dynamics principles in the Jet and Space Propulsion.	K_3
CO4	Understand the phenomenon of shock waves and its effect on flow. To gain some basic knowledge about jet propulsion and Rocket Propulsion.	K3
CO5	Upon completion of this course, the students can able to successfully apply gas dynamics principles in the Jet and Space Propulsion.	K3

KL- Bloom's Knowledge Level (K_1, K_2, K_3, K_4, K_5, K_6)

K_1-Remember, K_2- Understand, K_3- Apply, K_4- Analyze, K_5- Evaluate, K_6- Create

Course Articulation Matrix: (Mapping of COs with POs & PSOs)

CO	CORRELATION WITH PROGRAM OUTCOMES												CORRELATION WITH PSOs	
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12	PSO1	PSO2
CO1	3						1		1					
CO2		1	2											
CO3				3									1	
CO4		2												

CO5		2												
CO(Average)	3	1	2	3			1		1				1	

3 –High; 2 –Medium; 1 –Low

SUSTAINABLE DEVELOPMENT

Subject Code: -	**Professional Elective**	**IA Marks**	**40**
Number of Lecture Hours/Week:-	**03**	**Term End Exam Marks**	**60**
Total Number of Lecture Hours: -	**45**	**CREDITS**	**03**

Course Objective:

1. To impart knowledge on the principles for balancing social, economic and environmental dimensions of development and the associated international and national frameworks.
2. Appreciate some of the scientific underpinnings of sustainability practice and how policymakers are trying to apply it for better governance of scarce resources.
3. Gain additional scientific knowledge regarding planetary boundaries and their influence on international economic development.

Assessment Plan:

Criteria	Description	Maximum Marks
Internal Assessment (IA)	Internal Examination	30
	Attendance/Discipline	5
	Assignment/ Seminar	5
Terminal Examination (TE)	Terminal Examination	60
Total		100
Attendance	A minimum of 75% Attendance is required to be maintained by a student to be qualified for taking up the End Semester examination. The allowance of 25% includes all types of leaves including medical leaves.	

Course Content:

Module 1

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

Module 2

ONE-DIMENSIONAL PROBLEMS: 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 and heat transfer. Longitudinal vibration frequencies and mode shapes. Fourth Order Beam Equation, Transverse deflections and Natural frequencies of beams.

Module 3

TWO-DIMENSIONAL SCALAR VARIABLE PROBLEMS: Second Order 2D Equations

involving Scalar Variable Functions, Variational formulation, Finite Element formulation, Triangular elements, Shape functions and element matrices and vectors. Application to Field Problems, Thermal problems, Torsion of Non circular shafts, Quadrilateral elements, Higher Order Elements.

Module 4

TWO-DIMENSIONAL VECTOR VARIABLE PROBLEM: Equations of elasticity, Plane stress, plane strain and ax symmetric problems. Body forces and temperature effects – Stress calculations – Plate and shell elements. Body forces and temperature effects – Stress calculations – Plate and shell elements.

Module 5

ISOPARAMETRIC FORMULATION: Natural co-ordinate systems, Iso-parametric elements, Shape functions for iso parametric elements, One and two dimensions. Serendipity elements – Numerical integration and application to plane stress problems – Matrix solution techniques. Solutions Techniques to Dynamic problems – Introduction to Analysis Software

Text /Reference Books:

1. Reddy. J.N., "An Introduction to the Finite Element Method", 3rd Edition, Tata McGraw- Hill, 2025
2. Seshu, P, "Text Book of Finite Element Analysis", Prentice-Hall of India Pvt. Ltd., New Delhi, 2007.

Course Outcomes:

At the end of this course students will demonstrate the ability

CO1. Describe the national and global environmental, economic and social issues and the principles of different sustainable development frameworks
CO2. Apply the sustainable development principles during the planning of developmental activities.
CO3. Understand the practice and policy of sustainable pathways to development.
CO4. Understand how development leaders can apply various attributes of sustainability (environmental, economic and social).
CO5. Be aware of the current international policy landscape for the Sustainable Development Goals.

Course Outcome No	Statement	Knowledge Level (KL)
CO1	Describe the national and global environmental, economic and social issues and the principles of different sustainable development frameworks	K_1
CO2	Apply the sustainable development principles during the planning of developmental activities.	K_2
CO3	Understand the practice and policy of sustainable pathways to development.	K_3
CO4	Understand how development leaders can apply various attributes of sustainability (environmental, economic and social).	K3
CO5	Be aware of the current international policy landscape for the Sustainable Development Goals.	K3

KL- Bloom's Knowledge Level (K_1, K_2, K_3, K_4, K_5, K_6)

K_1-Remember, K_2- Understand, K_3- Apply, K_4- Analyze, K_5- Evaluate, K_6- Create

Course Articulation Matrix: (Mapping of COs with POs & PSOs)

CO	CORRELATION WITH PROGRAM OUTCOMES												CORRELATION WITH PSOs	
	PO1	PO2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO12	PSO1	PSO 2
CO1	3						1		1					
CO2		1	2											
CO3				3									1	
CO4		2												
CO5		2												
CO(Average)	3	1.66	2	3			1		1				1	

3 –High; 2 –Medium; 1 –Low

INTERNET OF THINGS

Subject Code: -	**Professional Elective**	**IA Marks**	**40**
Number of Lecture Hours/Week:-	**03**	**Term End Exam Marks**	**60**
Total Number of Lecture Hours: -	**45**	**CREDITS**	**03**

Course Objective:

1. Students will understand the concepts of Internet of Things and can able to build IoT applications.

Assessment Plan:

Criteria	Description	Maximum Marks
Internal Assessment (IA)	Internal Examination	30
	Attendance/Discipline	5
	Assignment/ Seminar	5
Terminal Examination (TE)	Terminal Examination	60
Total		100
Attendance	A minimum of 75% Attendance is required to be maintained by a student to be qualified for taking up the End Semester examination. The allowance of 25% includes all types of leaves including medical leaves.	

Course Content:

Module 1

INTRODUCTION TO IOT: Defining IoT, Characteristics of IoT, and Physical design of IoT. Logical design of IoT, Functional blocks of IoT, Communication models &APIs.

Module 2

IOT & M2M: Machine to Machine, Difference between IoT and M2M.Software define Network

Module 3

NETWORK & COMMUNICATION ASPECTS: Wireless medium access issues, MAC

protocol survey. Survey routing protocols, Sensor deployment & Node discovery. Data aggregation & dissemination.

Module 4
CHALLENGES IN IOT: Design challenges, Development challenges. Security challenges, other challenges.

Module 5
DOMAIN SPECIFIC APPLICATIONS OF IOT: Home automation, Industry applications. Surveillance applications, Other IoT applications.

Course Outcomes:

At the end of this course students will demonstrate the ability
CO1. Understand the concepts of Internet of Things
CO2. Analyze basic protocols in wireless sensor network.
CO3. Design IoT applications in different domain and be able to analyze their performance.
CO4. Implement basic IoT applications on embedded platform.
CO5. Application of IoT in automation of Commercial and Real-world examples

Course Outcome No	Statement	Knowledge Level (KL)
CO1	Understand the concepts of Internet of Things	K_1
CO2	Analyze basic protocols in wireless sensor network.	K_2
CO3	Design IoT applications in different domain and be able to analyze their performance.	K_3
CO4	Implement basic IoT applications on embedded platform	K3
CO5	Application of IoT in automation of Commercial and Real-world examples	K3

KL- Bloom's Knowledge Level (K_1, K_2, K_3, K_4, K_5, K_6)

K_1-Remember, K_2- Understand, K_3- Apply, K_4- Analyze, K_5- Evaluate, K_6- Create

Course Articulation Matrix: (Mapping of COs with POs & PSOs)

CO	CORRELATION WITH PROGRAM OUTCOMES												CORRELATION WITH PSOs	
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12	PSO1	PSO2
CO1	3						1		1					
CO2		1	2											
CO3				3									1	
CO4		2												
CO5											2	2		
CO(Average)	3	1.5	2	3			1		1		2	2	1	

3 –High; 2 –Medium; 1 –Low

ENGINEERING PROJECT-3

Subject Code: - BTMT803P	**IA Marks 80**
Number of Lecture Hours/Week: -	**Term End Exam Marks 120**
Total Number of Lecture Hours: -	**CREDITS 08**

Course Objective:
Following are the intended objectives of the Project work:

The object of Project Work & Dissertation is to enable the student to extend further the investigative study, either fully theoretical/practical or involving both theoretical and practical work, under the guidance of a Supervisor from the Department alone or jointly with a Supervisor drawn from R&D laboratory/Industry. This is expected to provide a good training for the student(s) in R&D work and technical leadership. The assignment to normally include:

1. In-depth study of the topic assigned in the light of the Report;
2. Review and finalization of the Approach to the Problem relating to the assigned topic;
3. Preparing an Action Plan for conducting the investigation, including team work;
4. Detailed Analysis/Modeling/Simulation/Design/Problem Solving/Experiment as needed;
5. Final development of product/process, testing, results, conclusions and future directions;
6. Preparing a paper for Conference presentation/Publication in Journals, if possible;
7. Preparing a Dissertation in the standard format for being evaluated by the Department.
8. Final Seminar Presentation before a Departmental Committee.

Assessment Plan:

Criteria	Description	Maximum Marks
Internal Assessment (IA)	Internal Examination	80
Terminal Examination (TE)	Terminal Examination	120
Total		200
Attendance	A minimum of 75% Attendance is required to be maintained by a student to be qualified for taking up the End Semester examination. The allowance of 25% includes all types of leaves including Medical leaves.	

GUIDELINES FOR PROJECT WORK

The Project work should be based on real/ live problems of the Industry/Govt./NGO/ MSME/Rural Sector or an innovative idea having the potential of a Startup and this project to be carried over to next semester.