Course Structure & Syllabi

Four Year B. Tech in Metallurgical and Materials Engineering

With Effect from Academic Session 2023-2024

Department of Metallurgical Engineering

School of Mines & Metallurgy

A Constituent of Kazi Nazrul University, Asansol - 713340

Preamble:

The purpose of a Learning Outcome-based Curriculum Framework (LOCF) is to change the paradigm of higher education from a teacher-centric to learner-centric curriculum. It is hoped that this paradigmatic change will bring about a significant improvement in the quality of higher education and make the learners both competent and confident to face the challenges of a modern competitive world. The philosophy of this new curriculum framework is pragmatism, to realise that it is not enough for institutions of higher learning to produce good humans and responsible citizens of the country but also to produce employed graduates and postgraduates. After all, it is not prudent to expect an unemployed youth to cherish values like humanity and responsibility towards the nation; he/she first needs to have productive employment to nourish such values.

LOCF seeks to make higher education in India learner-centric so that graduates and postgraduates not only have a more holistic understanding of their subject but also be able to better serve the humanity with dignity and honour, which can be expected only if they are able to secure productive employment after completing their higher education degrees.

Introduction to Learning Outcome Based Curriculum Framework (LOCF) in Kazi Nazrul University:

Four-year BTech programs in Kazi Nazrul University have been designed as a base for research and application of knowledge. The syllabus and curricula of the BTech programmes have been developed following the UGC LOCF guidelines and through rigorous academic exercises after consulting eminent academic experts and feedback received from various stakeholders of the University. These four-year programs will enable the students to join the workforce in their respective fields. Kazi Nazrul University has an aim to develop the future generation learners sensitive towards the developmental challenges of the nation with special emphasis on the local developmental needs. The University also aims to foster this future generation of learners with a systematic understanding of global development need. The learning outcome-based curricula of different disciplines reflect the national as well as global sustainable needs listed below in the respective programme and course specific outcomes:

National needs:

- Promote the Right to Education.
- Inculcate ethical and professional values.
- Increase national and international visibility.
- leverage institutional strengths through strategic partnerships.
- enlarge the academic community within which to benchmark their activities.
- mobilize internal intellectual resources.

- add important, contemporary learning outcomes to student experience.
- Develop stronger research groups.
- Encourage multidisciplinary.
- Promote Cross cultural exchanges.
- Preservation of traditional knowledge
- Creating human resource for Economic growth
- Promotion of scientific mind-set and critical thinking

Sustainable development needs:

- Help to eradicate poverty.
- Ensuring meal for all
- Promoting good health and well being
- Promoting quality education
- Promoting gender equality
- Initiatives for clean water and sanitization
- Programmes to reduce inequalities.
- Develop sustainable cities and communities.
- promote decent work and economic growth.
- initiate industry-academia collaboration for innovative research
- encourage responsible consumer behavior.
- encourage pro-environment awareness.

Program Outcomes (PO)s:

The overall program outcome of the LOCF at BTech level are to:

- help formulate undergraduate attributes, qualification descriptors, programme learning outcomes and course learning outcomes that are expected to be demonstrated by the holder of a BTech degree;
- enable prospective students, parents, employers and others to understand the nature and level of learning outcomes (knowledge, skills, attitudes and values) or attributes a graduate/postgraduate should be capable of demonstrating on successful completion of BTech.

- maintain national standards and international comparability of standards to ensure global competitiveness, and to facilitate postgraduate mobility; and
- provide higher education institutions and their stake holders an important point of reference for setting and assessing standards.

Undergraduate Attributes:

The undergraduate attributes reflect the particular quality and feature or characteristics of an individual, including the knowledge, skills, attitudes and values that are expected to be acquired by an undergraduate through studies at the higher education institution (HEI) such as a college or university. Such attributes include capabilities that help strengthen one's abilities for widening current knowledge base and skills, gaining new knowledge and skills, undertaking future studies and performing well in a chosen career and playing a constructive role as responsible citizen of the country. The Attributes define the characteristics of a student's university degree programme (s), and describe a set of characteristics/competencies that are designed to be transferable beyond the particular disciplinary area and programme contexts in which they have been developed. Such attributes are fostered through meaningful learning experiences made available through the curriculum, the total college/university experiences and a process of critical and reflective thinking.

The learning outcomes-based curriculum framework is based on the premise that every student is unique. Each student has his/her own characteristics in terms of previous learning levels and experiences, life experiences, learning styles and approaches to future career-related actions. The quality, depth and breadth of the learning experiences made available to the students while at the college/University help develop their characteristic attributes. The postgraduate attributes reflect both disciplinary knowledge and understanding and generic/global skills and competencies that all students in different academic fields of study should acquire/attain and demonstrate. Some of the desirable attributes which a postgraduate student should demonstrate will include the following:

- ***Disciplinary Knowledge:*** Demonstrate comprehensive knowledge and understanding of one or more disciplines that form a part of a programme of study, and knowledge and skills acquired from interaction with educators and peer group throughout the programme of study.
- ***Communication Skills:*** Express thoughts and ideas effectively in writing and orally, communicate with others using appropriate media, confidently share one's views and express herself/himself, demonstrate the ability to listen carefully, read and write analytically, and present complex information in a clear and concise manner to different groups.
- ***Critical Thinking:*** Apply analytic thought to a body of knowledge, analyse and evaluate evidence, arguments, claims, beliefs on the basis of empirical evidence, identify relevant assumptions or implications, formulate coherent arguments, critically evaluate practices, policies and theories by following scientific approach to knowledge development.
- ***Problem Solving:*** Demonstrate capacity to extrapolate from what one has learned and apply their competencies to solve different kinds of non-familiar problems, rather than replicate curriculum content knowledge and apply one's learning to real life situations.
- ***Analytical Reasoning****:* Demonstrate the ability to evaluate the reliability and relevance of evidence, identify logical flaws and holes in the arguments of others, analyses and synthesize data from a variety of sources, draw valid conclusions and support them with evidence and examples, and addressing opposing viewpoints.

- ***Research-related Skills**:* Demonstrate a sense of inquiry and capability for asking relevant/appropriate questions, problematising, synthesising and articulating, demonstrate the ability to recognize cause-and-effect relationships, define problems, formulate hypotheses, test hypotheses, analyse, interpret and draw conclusions from data, establish hypotheses, predict cause-and-effect relationships, plan, execute and report the results of an experiment or investigation.
- ***Collaboration/Cooperation/Teamwork**:* Demonstrate ability to work effectively and respectfully with diverse teams, facilitate cooperative or coordinated effort on the part of a group, and act together as a group or a team in the interests of a common cause and work efficiently as a member of a team.
- ***Scientific Reasoning using Quantitative/Qualitative Data**:* Demonstrate the ability to understand cause-and-effect relationships, define problems, apply scientific principles, analyse, interpret and draw conclusions from quantitative/qualitative data, and critically evaluate ideas, evidence and experiences from an open-minded and reasoned perspective.
- ***Reflective Thinking:*** Demonstrate critical sensibility to lived experiences, with self-awareness and reflexivity of both self and society.
- ***Information/Digital Literacy:*** Demonstrate capability to use ICT in a variety of learning situations, demonstrate ability to access, evaluate, and use a variety of relevant information sources and to use appropriate software for analysis of data.
- ***Self-Directed Learning:*** Demonstrate ability to work independently, identify appropriate resources required for a project, and manage a project through to completion.
- ***Multicultural Competence:*** Demonstrate knowledge of the values and beliefs of multiple cultures and a global perspective, effectively engage in a multicultural society, interact respectfully with diverse groups.
- ***Moral and Ethical Awareness/Reasoning**:* Demonstrate the ability to embrace moral/ethical values in conducting one's life, formulate a position/argument about an ethical issue from multiple perspectives, and use ethical practices in all work. Demonstrate the ability to identify ethical issues related to one's work, avoid unethical behaviour such as fabrication, falsification or misrepresentation of data or committing plagiarism, not adhering to intellectual property rights, appreciate environmental and sustainability issues, and adopt objective, unbiased and truthful actions in all aspects of work.
- ***Community Engagement:*** Demonstrate responsible behaviour and ability to engage in the intellectual life of the educational institution, and participate in community and civic affairs.
- ***Leadership Readiness/Qualities**:* Demonstrate capability for mapping out where one needs to go to "win" as a team or an organization, and set direction, formulate an inspiring vision, build a team who can help achieve the vision, motivate and inspire team members to engage with that vision, and use management skills to guide people to the right destination, in a smooth and efficient way.
- ***Lifelong Learning**:* Demonstrate the ability to acquire knowledge and skills, including 'learning how to learn' that are necessary for participating in learning activities throughout life, through self-paced and self-directed learning aimed at personal development, meeting economic, social and cultural objectives, and adapting to changing trades and demands of workplace through knowledge/skill development/reskilling.

Brief History of the Department:

Department of Metallurgical Engineering has started its journey under School of Mines & Metallurgy in Kazi Nazrul University in the year 2017. The department offers 6 semesters diploma in Metallurgical Engineering from the year 2017 and 8 semester degree in Metallurgical Engineering from the year 2019. Both the courses are approved by All India Council for Technical Education (AICTE), Government of India. The students are admitted through WBJEE for degree programme and through JEXPO for diploma programme.

The Department has its own Board of Studies (BOS) with experts from eminent institutes, e.g. IITs and NITs. Faculty members are also engaged in collaborative research with different eminent academic and research institutes, and industries. Students have already undertaken vocational training in various reputed organizations like IISCO Burnpur, Tata Hitachi, Kharagpur, and nearby iron and steel plants.

Vision of the Department:

The vision of the department is to strengthen education, research and interaction between various industry and institute in order to cater a bunch of dedicated, skilled and knowledgeable mining engineers to fulfill the need of the mining industry.

Mission of the Department:

To translate the vision into reality, the department is committed:

- To provide technical education to students in such a way that they can analysis and design various operation of mining and materials systems.
- To update the curriculum with new innovation in technology in the field of mining and allied industries.
- To work intensely with industry in pursuit of the above goals of education and research, leading to the development of cutting edge and commercially-viable technologies.

Programme Educational Objectives (PEOs):

The students are expected to obtain the following programme educational objectives after the completion of the course:

- Apply knowledge of mining engineering to extract coal/minerals keeping in view the safety, conservation and economical aspects.
- Work effectively with other engineering and science teams as a team member or leader in multidisciplinary projects.

Program Specific Outcomes (PSOs):

At the end of the degree program, the student will be:

- Able to work in a managerial capacity in a mine to look after the overall safety, conservation and economical aspects.
- Able to work as a planning engineer to carry out the short term and long term planning to operate a mine.
- Able to work as a blasting engineer in underground tunneling and hydel power project.

- Able to work as a surveyor in mining and civil projects.

Global Needs	BTCMTBSC101	BTCMTBSC102	BTCMTESC101	BTCMTESC102	BTCMTHSMC201	BTCMTBSC201	BTCMTBSC202	BTCMTESC201	BTCMTESC202
Systems thinking competency	√	√			√	√	√	√	√
Anticipatory competency			√	√					
Normative competency					√	√			
Strategic competency									√
Transdisciplinary collaboration competency	√	√	√	√	√	√	√	√	√
Critical thinking competency					√	√	√	√	√
Creativity competency			√		√	√			
Self-awareness competency			√		√	√			
Integrated problem-solving competency			√		√	√			

Global Needs	BTCMTHSMC301	BTCMTBSC301	BTCMTBSC302	BTCMTESC301	BTCMTESC302	BTCMTPCC301	BTCMTPCC302	BTCMTMC301	BTCMTHSMC401	BTCMTPCC401	BTCMTPCC402	BTCMTPCC403	BTCMTPEC401	BTCMTPEC402	BTCMTOEC401	BTCMTOEC402
Systems thinking competency	√		√				√	√	√	√	√		√	√	√	√
Anticipatory competency				√		√										
Normative competency							√	√						√	√	√
Strategic competency											√					
Transdisciplinary collaboration competency	√		√	√		√	√	√	√	√	√		√	√	√	√
Critical thinking competency							√	√	√	√	√					
Creativity competency				√			√	√								
Self-awareness competency				√			√	√						√	√	√
Integrated problem-solving competency				√			√	√		√	√	√	√	√		

Global Needs	BTCMTPCC501	BTCMTPCC502	BTCMTPCC503	BTCMTPCC504	BTCMTPEC501	BTCMTPEC502	BTCMTPEC503	BTCMTPEC504	BTCMTPEC505	BTCMTPEC506	BTCMTPCC601	BTCMTPCC602	BTCMTPCC603	BTCMTPCC604	BTCMTPEC601	BTCMTPEC602	BTCMTOEC601	BTCMTOEC602	BTCMTPROJ601	BTCMTMC601
Systems thinking competency	√	√			√	√	√	√	√			√	√	√	√					√
Anticipatory competency			√	√										√	√	√	√	√	√	
Normative competency					√	√														
Strategic competency									√		√	√	√	√						
Transdisciplinary collaboration competency	√	√	√	√	√	√	√	√	√											√
Critical thinking competency					√	√	√	√	√				√	√	√	√		√	√	
Creativity competency			√		√	√														
Self-awareness competency			√		√	√					√	√	√	√						

Integrated problem-solving competency			√		√	√							√	√	√	√		√		

Global Needs	BTCMTPCC701	BTCMTPCC702	BTCMTPCC703	BTCMTPEC701	BTCMTPEC702	BTCMTOEC701	BTCMTOEC702	BTCMTOEC703	BTCMTOEC704	BTCMTLC701	BTCMTPROJ701	BTCMTOEC801	BTCMTOEC802	BTCMTPROJ801	BTCMTLC801
Systems thinking competency	√	√			√	√	√					√	√		
Anticipatory competency			√	√											
Normative competency					√	√									
Strategic competency													√		
Transdisciplinary collaboration competency	√	√	√	√	√	√	√					√	√		
Critical thinking competency					√	√	√					√	√		
Creativity competency			√		√	√									
Self-awareness			√		√	√									

competency															
Integrated problem-solving competency			√		√	√			√		√	√			

National needs	BTCMTBSC101	BTCMTBSC102	BTCMTESC101	BTCMTESC102	BTCMTHSMC201	BTCMTBSC201	BTCMTBSC202	BTCMTESC201	BTCMTESC202
Promote Right to education	√	√			√	√	√	√	√
Inculcate ethical and professional values			√	√					
Increase national and international visibility;					√	√			
Leverage institutional strengths through strategic partnerships;									√
Enlarge the academic community within which to benchmark their activities;	√	√	√	√	√	√	√	√	√
Mobilise internal intellectual resources;					√	√	√	√	√
Add important, contemporary learning outcomes to student experience;			√		√	√			
Develop stronger research groups.			√		√	√			
Encourage multidisciplinary			√		√	√			
Promote Cross cultural exchanges	√	√	√	√	√	√	√	√	√

Preservation of traditional knowledge						√	√	√	√	√						
Creating human resource for Economic growth			√			√	√									
Promotion of scientific mind-set and critical thinking			√			√	√									

National needs	BTCMTHSMC301	BTCMTBSC301	BTCMTBSC302	BTCMTESC301	BTCMTESC302	BTCMTPCC301	BTCMTPCC302	BTCMTMC301	BTCMTHSMC401	BTCMTPCC401	BTCMTPCC402	BTCMTPCC403	BTCMTPEC401	BTCMTPEC402	BTCMTOEC401	BTCMTOEC402
Promote Right to education	√	√			√	√	√	√	√					√	√	√
Inculcate ethical and professional values			√	√								√	√	√	√	√
Increase national and international visibility;					√	√										
Leverage institutional strengths through strategic partnerships;									√			√	√	√	√	√
Enlarge the academic community within which to benchmark their activities;	√	√	√	√	√	√	√	√	√							
Mobilise internal intellectual resources;					√	√	√	√	√							
Add important, contemporary learning outcomes to student experience;			√		√	√					√	√	√	√	√	
Develop stronger research groups.			√		√	√										
Encourage multidisciplinary			√		√	√							√	√	√	√

Promote Cross cultural exchanges					√	√	√	√	√								
Preservation of traditional knowledge			√		√	√								√	√	√	
Creating human resource for Economic growth			√		√	√											
Promotion of scientific mind-set and critical thinking			√		√	√				√	√	√	√	√			

National needs	BTCMTPCC501	BTCMTPCC502	BTCMTPCC503	BTCMTPCC504	BTCMTPEC501	BTCMTPEC502	BTCMTPEC503	BTCMTPEC504	BTCMTPEC505	BTCMTPEC506	BTCMTPCC601	BTCMTPCC602	BTCMTPCC603	BTCMTPCC604	BTCMTPEC601	BTCMTPEC602	BTCMTOEC601	BTCMTOEC602	BTCMTPROJ601	BTCMTMC601
Promote Right to education	√	√			√	√	√	√	√			√	√	√	√					√
Inculcate ethical and professional values			√	√										√	√	√	√	√	√	
Increase national and international visibility;					√	√														
Leverage institutional strengths through strategic partnerships;									√		√	√	√	√						

Enlarge the academic community within which to benchmark their activities;	√	√	√	√	√	√	√	√	√										√
Mobilise internal intellectual resources;					√	√	√	√	√			√	√	√	√		√	√	
Add important, contemporary learning outcomes to student experience;			√		√	√													
Develop stronger research groups.			√		√	√				√	√	√	√						
Encourage multidisciplinary			√		√	√						√	√	√	√		√		
Promote Cross cultural exchanges		√	√									√	√	√	√	√	√		√
Preservation of traditional knowledge				√	√														
Creating human resource for Economic growth							√		√	√	√	√							

Promotion of scientific mind-set and critical thinking		√	√	√	√	√	√	√											√	√

National needs	BTCMTPCC701	BTCMTPCC702	BTCMTPCC703	BTCMTPEC701	BTCMTPEC702	BTCMTOEC701	BTCMTOEC702	BTCMTOEC703	BTCMTOEC704	BTCMTLC701	BTCMTPROJ701	BTCMTOEC801	BTCMTOEC802	BTCMTPROJ801	BTCMTLC801
Promote Right to education	√	√			√	√	√	√	√		√	√			
Inculcate ethical and professional values			√	√										√	√
Increase national and international visibility;					√	√						√	√		
Leverage institutional strengths through strategic partnerships;									√						√
Enlarge the academic community within which to benchmark their activities;	√	√	√	√	√	√	√	√	√		√	√			
Mobilise internal intellectual resources;					√	√	√	√	√			√	√	√	√
Add important, contemporary learning outcomes to student experience;			√		√	√									√
Develop stronger research groups.			√		√	√					√	√			
Encourage multidisciplinary	√	√			√	√	√	√	√					√	√
Promote Cross cultural exchanges			√	√							√	√			

Preservation of traditional knowledge					√	√								√	√
Creating human resource for Economic growth									√			√	√		
Promotion of scientific mind-set and critical thinking			√		√	√			√	√			√	√	

Sustainable development needs:	BTCMTBSC101	BTCMTBSC102	BTCMTESC101	BTCMTESC102	BTCMTHSMC201	BTCMTBSC201	BTCMTBSC202	BTCMTESC201	BTCMTESC202
Help to eradicate poverty	√	√			√	√	√	√	√
Ensuring meal for all			√	√					
Promoting good health and well being					√	√			
Promoting quality education									√
Promoting gender equality	√	√	√	√	√	√	√	√	√
Initiatives for clean water and sanitization					√	√	√	√	√
Programmes to reduce inequalities			√		√	√			
Develop sustainable cities and communities			√		√	√			
Promote decent work and economic growth			√		√	√			

Initiate industry-academia collaboration for innovative research	√		√		√		√		√		√		√		√		√
Encourage responsible consumer behaviour									√		√		√		√		√
Encourage pro-environment awareness					√				√		√						

Sustainable development needs	BTCMTHSMC301	BTCMTBSC301	BTCMTBSC302	BTCMTESC301	BTCMTESC302	BTCMTPCC301	BTCMTPCC302	BTCMTMC301	BTCMTHSMC401	BTCMTPCC401	BTCMTPCC402	BTCMTPCC403	BTCMTPEC401	BTCMTPEC402	BTCMTOEC401	BTCMTOEC402	BTCMTHSMC301
Help to eradicate poverty	√	√			√	√	√	√	√								
Ensuring meal for all			√	√								√	√	√	√	√	
Promoting good health and well being					√	√								√	√	√	√
Promoting quality education									√		√	√	√	√	√		
Promoting gender equality	√	√	√	√	√	√	√	√	√								
Initiatives for clean water and sanitization					√	√	√	√	√				√	√	√	√	√
Programmes to reduce inequalities			√		√	√				√	√	√	√	√			
Develop sustainable cities and communities			√		√	√											
Promote decent work and economic growth			√		√	√								√	√	√	√

Initiate industry-academia collaboration for innovative research					√	√	√	√	√		√	√	√	√	√		
Encourage responsible consumer behaviour			√		√	√							√	√	√	√	√
Encourage pro-environment awareness			√		√	√				√	√	√	√	√			

Sustainable development needs:	BTCMTPCC501	BTCMTPCC502	BTCMTPCC503	BTCMTPCC504	BTCMTPEC501	BTCMTPEC502	BTCMTPEC503	BTCMTPEC504	BTCMTPEC505	BTCMTPEC	BTCMTPCC6	BTCMTPCC6	BTCMTPCC6	BTCMTPCC6	BTCMTPEC601	BTCMTPEC	BTCMTOEC601	BTCMTOEC602	BTCMTPRO601	BTCMTMC601
Help to eradicate poverty	√	√			√	√	√	√	√			√	√	√	√					√
Ensuring meal for all			√	√										√	√	√	√	√	√	
Promoting good health and well being					√	√														
Promoting quality education									√		√	√	√	√						
Promoting gender equality	√	√	√	√	√	√	√	√	√											√
Initiatives for clean water and sanitization					√	√	√	√	√				√	√	√	√		√	√	
Programmes to reduce inequalities			√		√	√														
Develop sustainable cities and communities			√		√	√					√	√	√	√						
Promote decent work and economic growth			√		√	√							√	√	√	√		√		

Initiate industry-academia collaboration for innovative research		√	√									√	√	√	√	√	√		√
Encourage responsible consumer behaviour				√	√														
Encourage pro-environment awareness								√		√	√	√	√						

Sustainable development needs:	BTCMTPCC701	BTCMTPCC702	BTCMTPCC703	BTCMTPEC701	BTCMTPEC702	BTCMTOEC701	BTCMTOEC702	BTCMTOEC703	BTCMTOEC704	BTCMTLC701	BTCMTPROJ701	BTCMTOEC801	BTCMTOEC802	BTCMTPROJ801	BTCMTLC801
Help to eradicate poverty	√	√			√	√	√	√	√		√	√	√	√	
Ensuring meal for all			√	√				√	√	√	√				
Promoting good health and well being					√	√			√	√	√	√			
Promoting quality education									√						
Promoting gender equality	√	√	√	√	√	√	√	√	√						
Initiatives for clean water and sanitization					√	√	√	√	√						
Programmes to reduce inequalities			√		√	√				√	√	√	√		
Develop sustainable cities and communities			√		√	√			√	√	√	√			

Promote decent work and economic growth	√	√			√	√	√	√	√		√	√	√	√	
Initiate industry-academia collaboration for innovative research			√	√				√	√	√	√				
Encourage responsible consumer behaviour					√	√					√	√	√	√	
Encourage pro-environment awareness									√	√	√	√	√		

SCHOOL OF MINES & METALLURGY
A Constituent of KAZI NAZRUL UNIVERSITY, Asansol
B.Tech in Metallurgical and Materials Engineering
CURRICULAR STRUCTURE FOR FIRST YEAR (FIRST SEMESTER)

SL. NO.	SUBJECT	CATEGORY	COURSE CODE	CREDITS	PERIODS			EVALUATION SCHEME				
					L	TU	PR	INTERNAL ASSESSMENT (IA)		END SEMESTER EXAMINATION (ESE)		
								TH	PR	TH	PR	TOTAL
1	Physics	Basic Science Course	BTCMTBSC101	5.5	3	1	3	30	20	70	30	150
2	Mathematics - I	Basic Science Course	BTCMTBSC102	4	3	1	0	30		70		100
3	Basic Electrical Engineering	Engineering Science Course	BTCMTESC101	5	3	1	2	30	20	70	30	150
4	Engineering Graphics and Design	Engineering Science Course	BTCMTESC102	3	0	1	4		50		50	100
TOTAL				**17.5**	**9**	**4**	**9**					**500**

STUDENT CONTACT HOURS PER WEEK: 22 hours; DURATION: 18 WEEKS / SEMESTER

Theory and Practical Period of 60 Minutes each.

L- Lecture, TU- Tutorials, PR- Practical, IA- Internal Assessment, ESE- End Semester Exam.

SCHOOL OF MINES & METALLURGY
A Constituent of KAZI NAZRUL UNIVERSITY, Asansol
B Tech in Metallurgical and Materials Engineering
CURRICULAR STRUCTURE FOR FIRST YEAR (SECOND SEMESTER)

SL. NO.	SUBJECT	CATEGORY	COURSE CODE	CREDITS	PERIODS			EVALUATION SCHEME				
					L	TU	PR	INTERNAL ASSESSMENT (IA)		END SEMESTER EXAMINATION (ESE)		
								TH	PR	TH	PR	TOTAL
1	Communicative English	Humanities and Social Sciences including Management Course	BTCMTHSMC201	3	2	0	2	30	20	70	30	150
2	Chemistry	Basic Science Course	BTCMTBSC201	5.5	3	1	3	30	20	70	30	150
3	Mathematics - II	Basic Science Course	BTCMTBSC202	4	3	1	0	30		70		100
4	Introduction to C Programing	Engineering Science Course	BTCMTESC201	5	3	0	4	30	20	70	30	150
5	Workshop Practices	Engineering Science Course	BTCMTESC202	3	0	1	4		50		50	100
TOTAL				**20.5**	**11**	**3**	**13**					**650**

STUDENT CONTACT HOURS PER WEEK: 27 hours; DURATION: 18 WEEKS / SEMESTER

Theory and Practical Period of 60 Minutes each.

L- Lecture, TU- Tutorials, PR- Practical, IA- Internal Assessment, ESE- End Semester Exam**.**

SCHOOL OF MINES & METALLURGY
A Constituent of KAZI NAZRUL UNIVERSITY, Asansol
B. Tech in Metallurgical and Materials Engineering
CURRICULAR STRUCTURE FOR SECOND YEAR (THIRD SEMESTER)

SL. NO.	SUBJECT	CATEGORY	COURSE CODE	CREDITS	PERIODS			EVALUATION SCHEME				
					L	TU	PR	INTERNAL ASSESSMENT (IA)		END SEMESTER EXAMINATION (ESE)		
								TH	PR	TH	PR	TOTAL
1	Economics for Engineers	Humanities and Social Sciences including Management courses	BTCMTHSMC301	3	3	0	0	30		70	0	100
2	Biology	Basic Science Course	BTCMTBSC301	3	2	1	0	30		70	0	100
3	Mathematics III	Basic Science Course	BTCMTBSC302	4	3	1	0	30		70	0	100
4	Strength of Materials	Engineering Science Course	BTCMTESC301	3	3	0	0	30		70	0	100
5	Engineering Mechanics	Engineering Science Course	BTCMTESC302	4	3	1	0	30		70	0	100
6	Introduction to Materials Science	Professional Core Course	BTCMTPCC301	3	3	0	0	30		70	0	100
7	Materials Thermodynamics	Professional Core Course	BTCMTPCC302	3	3	0	0	30		70	0	100
8	Environmental Sciences	Mandatory Course	BTCMTMC301	0	0	0	0	15		35		50
TOTAL				**23**	**20**	**3**	**0**					**750**

STUDENT CONTACT HOURS PER WEEK: 23 hours; DURATION: 18 WEEKS / SEMESTER
Theory and Practical Period of 60 Minutes each.
L- Lecture, TU- Tutorials, PR- Practical, IA- Internal Assessment, ESE- End Semester Exam.

SCHOOL OF MINES & METALLURGY
A Constituent of KAZI NAZRUL UNIVERSITY, Asansol
B Tech in Metallurgical and Materials Engineering
CURRICULAR STRUCTURE FOR SECOND YEAR (FOURTH SEMESTER)

SL. NO.	SUBJECT	CATEGORY	COURSECODE	CREDITS	PERIODS			EVALUATION SCHEME				
					L	TU	PR	INTERNAL ASSESSMENT (IA)		END SEMESTER EXAMINATION (ESE)		
								TH	PR	ESE	PR	TOTAL
1	Universal Human Values II: Understanding Harmony	Humanities and Social Sciences including Management courses	BTCMTHSMC401	3	2	1	0	50		50	0	100
2	Physical Metallurgy	Professional Core Course	BTCMTPCC401	4	3	0	2	30	20	70	30	150
3	Principles of Extractive Metallurgy	Professional Core Course	BTCMTPCC402	3	3	0	0	30		70	0	100
4	Mechanical Metallurgy	Professional Core Course	BTCMTPCC403	4	3	0	2	30	20	70	30	150
5	Fundamentals of Non-ferrous Metals	Professional Elective Course (Any One)	BTCMTPEC401	3	3	0	0	30		70	0	100
	Light Metals and Alloys		BTCMTPEC402									
6	Mineral Processing	Open Elective Course (Any One)	BTCMTOEC401	3	3	0	0	30		70	0	100
	Chemical Processing		BTCMTOEC402									
TOTAL				**20**	**17**	**1**	**4**					**700**

STUDENT CONTACT HOURS PER WEEK: 22 hours; DURATION: 18 WEEKS / SEMESTER
Theory and Practical Period of 60 Minutes each.
L- Lecture, TU- Tutorials, PR- Practical, IA- Internal Assessment, ESE- End Semester Exam.

SCHOOL OF MINES & METALLURGY
A Constituent of KAZI NAZRUL UNIVERSITY, Asansol
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CURRICULAR STRUCTURE FOR THIRD YEAR (FIFTH SEMESTER)

SL. NO.	SUBJECT	CATEGORY	COURSE CODE	CREDITS	PERIODS			EVALUATION SCHEME				
					L	TU	PR	INTERNAL ASSESSMENT(IA)		END SEMESTER EXAMINATION (ESE)		
								TH	PR	TH	PR	TOTAL
1	Phase Transformations	Professional Core Course	BTCMTPCC501	4	3	0	2	30	20	70	30	150
2	Materials Characterization	Professional Core Course	BTCMTPCC502	4	3	0	2	30	20	70	30	150
3	Foundry Process & Technology	Professional Core Course	BTCMTPCC503	4	3	0	2	30	20	70	30	150
4	Iron Making Process	Professional Core Course	BTCMTPCC504	3	3	0	0	30		70		100
5	Materials Processing	Professional Elective Course (Any One)	BTCMTPEC501	3	3	0	0	30		70		100
	Metal Forming Processes		BTCMTPEC502									
6	Composite Materials	Professional Elective Course (Any One)	BTCMTPEC503	3	3	0	0	30		70		100
	Novel and Sustainable Materials		BTCMTPEC504									
7	Ceramic and Polymeric Materials	Professional Elective Course (Any One)	BTCMTPEC505	3	3	0	0	30		70		100
	Surface Engineering		BTCMTPEC506									
TOTAL				**24**	**21**	**0**	**6**					**850**

STUDENT CONTACT HOURS PER WEEK: 27 hours; DURATION: 18 WEEKS / SEMESTER
Theory and Practical Period of 60 Minutes each.
L- Lecture, TU- Tutorials, PR- Practical, IA- Internal Assessment, ESE- End Semester Exam.

SCHOOL OF MINES & METALLURGY
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B. Tech in Metallurgical and Materials Engineering
CURRICULAR STRUCTURE FOR THIRD YEAR (SIXTH SEMESTER)

SL. NO.	SUBJECT	CATEGORY	COURSE CODE	CREDITS	PERIODS			EVALUATION SCHEME				
					L	TU	PR	INTERNAL ASSESSMENT (IA)		END SEMESTER EXAMINATION (ESE)		
								TH	PR	TH	PR	TOTAL
1	Steel Making Process	Professional Core Course	BTCMTPCC601	3	3	0	0	30		70	0	100
2	Environmental Degradation of Materials	Professional Core Course	BTCMTPCC602	4	3	0	2	30	20	70	30	150
3	Joining of Materials	Professional Core Course	BTCMTPCC603	4	3	0	2	30	20	70	30	150
4	Heat Treatment Technology	Professional Core Course	BTCMTPCC604	4	3	0	2	30	20	70	30	150
5	Powder Metallurgy	Professional Elective Course (Any One)	BTCMTPEC601	4	3	0	2	30	20	70	30	150
6	Computational Materials Engineering		BTCMTPEC602									
7	Industrial Management and Environmental Control	Open Elective Course (Any One)	BTCMTOEC601	3	3	0	0	30		70		100
8	Production & Operation Management		BTCMTOEC602									
9	Internship in Industry/Research Institute/Academic Institute	Project	BTCMTPROJ601	1	0	0	0		20		30	50
10	Indian Constitution	Mandatory Course	BTCMTMC601	0	0	0	0	15		35		50
TOTAL				**23**	**18**	**0**	**8**					**900**

STUDENT CONTACT HOURS PER WEEK: 26 hours; DURATION: 18 WEEKS / SEMESTER
Theory and Practical Period of 60 Minutes each.
L- Lecture, TU- Tutorials, PR- Practical, IA- Internal Assessment, ESE- End Semester Exam

SCHOOL OF MINES & METALLURGY
A Constituent of KAZI NAZRUL UNIVERSITY, Asansol
B.Tech in Metallurgical and Materials Engineering
CURRICULAR STRUCTURE FOR FOURTH YEAR (SEVENTH SEMESTER)

SL.NO.	SUBJECT	CATEGORY	COURSE CODE	CREDITS	PERIODS			EVALUATION SCHEME				
					L	TU	PR	INTERNAL ASSESSMENT (IA)		END SEMESTER EXAMINATION (ESE)		
								TH	PR	TH	PR	TOTAL
1	Design and Selection of Materials	Professional Core Course	BTCMTPCC701	3	3	0	0	30		70	0	100
2	Alloy Steel	Professional Core Course	BTCMTPCC702	3	3	0	0	30		70		100
3	Non-destructive Testing & Evaluation	Professional Core Course	BTCMTPCC703	4	3	0	2	30	20	70	30	150
4	Failure Mechanism & Analysis	Professional Elective Course (Any One)	BTCMTPEC701	3	3	0	0	30		70		100
5	Fatigue & Fracture Mechanics		BTCMTPEC702									
6	Principles of X-Ray Diffraction	Open Elective Course (Any One)	BTCMTOEC701	3	3	0	0	30		70		100
7	Principles of Electron Microscopy		BTCMTOEC702									
8	Quality Assurance & Quality Control	Open Elective Course (Any One)	BTCMTOEC703	3	3	0	0	30		70		100
9	Optimization Techniques		BTCMTOEC704									
10	Soft Skill Development	Laboratory Course	BTCMTLC701	1	0	0	2		20		30	**50**
11	Project Preliminary	Project	BTCMTPROJ701	1	0	0	2		20		30	**50**
TOTAL				**21**	**18**	**0**	**6**					**750**

STUDENT CONTACT HOURS PER WEEK: 24 hours; DURATION: 18 WEEKS / SEMESTER
Theory and Practical Period of 60 Minutes each.
L- Lecture, TU- Tutorials, PR- Practical, IA- Internal Assessment, ESE- End Semester Exam

SCHOOL OF MINES & METALLURGY
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CURRICULAR STRUCTURE FOR FOURTH YEAR (EIGHTH SEMESTER)

SL. NO.	SUBJECT	CATEGORY	COURSE CODE	CREDITS	PERIODS			EVALUATION SCHEME				
					L	TU	PR	INTERNAL ASSESSMENT(IA)		END SEMESTER EXAMINATION (ESE)		
								TH	PR	TH	PR	TOTAL
1	Advance Materials	Open Elective Course (Any One)	BTCMTOEC801	3	3	0	0	30		70		**100**
2	Functional Materials		BTCMTOEC802									
3	Project & Thesis	Project	BTCMTPROJ801	10	0	0	20		250		100	**350**
4	General Viva Voce	Laboratory course	BTCMTLC801	1	0	0	0				50	**50**
TOTAL				**14**	**3**	**0**	**20**					**500**

STUDENT CONTACT HOURS PER WEEK: 23 hours; DURATION: 18 WEEKS / SEMESTER
Theory and Practical Period of 60 Minutes each.
L- Lecture, TU- Tutorials, PR- Practical, IA- Internal Assessment, ESE- End Semester Exam**.**

1st Semester

Subject Name: Physics **Subject Code: BTCMTBSC101** **Subject Credit: 4**

Course Objectives:

To introduce the basic concepts of physics relevant to concerned branches of Engineering and Technology

Course Outcomes:

- Construction and working details of different instruments are learnt
- Study of magnetic and dielectric materials enhanceing the utility aspects of materials

Module 1: Electrostatics in vacuum (8 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 (4 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 centre of a dielectric sphere, charge in front of a dielectric slab, dielectric slab and dielectric sphere in uniform electric field.

Module 3: Magnetostatics (6 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: Magnetostatics in a linear magnetic medium (3 hours)

Magnetization and associated bound currents; auxiliary magnetic field; Boundary conditions on and 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 (4 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.

Module 6: Displacement current, Magnetic field due to time-dependent electric field and Maxwell's equations (5 hours)

Continuity equation for current densities; Modifying equation for the curl of magnetic field to satisfy continuity equation; displace current and magnetic field arising from time dependent electric field; calculating magnetic field due to changing electric fields in quasistatic approximation. Maxwell's equation in vacuum and non-conducting medium; Energy in an electromagnetic field; Flow of energy and Poynting vector with examples. Qualitative discussion of momentum in electromagnetic fields.

Module 7: Electromagnetic waves (8 hours)

The wave equation; Plane electromagnetic waves in vacuum, their transverse nature and polarization; relation between electric and magnetic fields of an electromagnetic wave; energy carried by electromagnetic waves and examples. Momentum carried by electromagnetic waves and resultant pressure. Reflection and transmission of electromagnetic waves from a non-conducting medium-vacuum interface for normal incidence.

Text/Reference Books

1. Griffiths, D. J., Introduction to Electrodynamics (3rd Edition), Prentice Hall; 1999
2. Walker, J., Halliday, D. and Resnick,R., Fundamentals of Physics (10thedition), John Wiley & Sons Inc; 2013
3. Gaur R. K. and Gupta, S. L., Engineering Physics, Dhanpat Raj Publications,2003
4. Palanisamy, P. K., Engineering Physics, Scitech Publications (P) Ltd, 2006
5. Arumugam, M., Engineering Physics, Anuradha Publications, 2000

Subject Name: Mathematics-1 **Subject Code: BTCMTBSC102** **Subject Credit: 4**

Course Objectives:

The objective of this course is to familiarize the prospective engineers with techniques in calculus, multivariate analysis and linear algebra. 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.

Course Outcomes:

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

- 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
- The fallouts of Rolle's Theorem that is fundamental to application of analysis to Engineering problems
- The tool of power series and Fourier series for learning advanced Engineering Mathematics
- To deal with functions of several variables that are essential in most branches of engineering
- The essential tool of matrices and linear algebra in a comprehensive manner

Module 1: Calculus (6 hours)

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: Calculus (6 hours)

Rolle's Theorem, Mean value theorems, Taylor's and Maclaurin theorems with remainders; indeterminate forms and L'Hospital's rule; Maxima and minima.

Module 3: Sequences and series (10 hours)

Convergence of sequence and series, tests for convergence; Power series, Taylor's series, series for exponential, trigonometric and logarithm functions; Fourier series: Half range sine and cosine series, Parseval's theorem.

Module 4: Multivariable Calculus (Differentiation) (8 hours)

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

Module 5: Matrices (10 Hours)

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

Text/Reference Books

1. Thomas G.B. and Finney, R.L.,Calculus and Analytic geometry, 9th Edition, Pearson, Reprint, 2002
2. Erwin Kreyszig, Advanced Engineering Mathematics, 9th Edition, John Wiley & Sons,2006
3. Veerarajan, T., Engineering Mathematics for first year, Tata McGraw-Hill, New Delhi, 2008
4. Ramana B.V., Higher Engineering Mathematics, Tata McGraw Hill New Delhi, 11th eprint, 2010
5. Poole, D., Linear Algebra: A Modern Introduction, 2nd Edition, Brooks/Cole, 2005
6. Bali, N.P. and Goyal, M., A textbook of Engineering Mathematics, Laxmi Publications, Reprint, 2008
7. Grewal, B.S., Higher Engineering Mathematics, Khanna Publishers, 36th Edition, 2010

Subject Name: Basic Electrical Engineering **Subject Code: BTCMTESC101** **Subject Credit: 4**

Course Objectives:

- To understand and analyze basic electric and magnetic circuits
- To study the working principles of electrical machines and power converters.
- To introduce the components of low voltage electrical installations

Course Outcomes:

At the end of the course, student will be:

- Able to analyse the various electrical networks
- Able to understand the operation of DC generators,3-point starter and DC machine testing by Swinburne's Test
- Able to analyse the performance of single-phase transformer
- Able to explain the operation of 3-phase alternator and 3-phase induction motors
- Able to analyse the operation of half wave, full wave bridge rectifiers and OP-AMPs
- Able to explain the single stage CE amplifier and concept of feedback amplifier

Module 1: DC Circuits (8 hours)

Electrical circuit elements (R, L and C), voltage and current sources, Kirchoff current and voltage laws, analysis of simple circuits with dc excitation. Superposition, Thevenin and Norton Theorems. Time-domain analysis of first-order RL and RC circuits.

Module 2: AC Circuits (8 hours)

Representation of sinusoidal waveforms, peak and rms values, phasor representation, real power, reactive power, apparent power, power factor. Analysis of single-phase ac circuits consisting of R, L, C, RL, RC, RLC combinations (series and parallel), resonance. Three-phase balanced circuits, voltage and current relations in star and delta connections.

Module 3: Transformers (6 hours)

Magnetic materials, BH characteristics, ideal and practical transformer, equivalent circuit, losses in transformers, regulation and efficiency. Auto-transformer and three-phase transformer connections.

Module 4: Electrical Machines (8 hours)

Generation of rotating magnetic fields, Construction and working of a three-phase induction motor, Significance of torque-slip characteristic. Loss components and efficiency, starting and speed control of induction motor. Single-phase induction motor. Construction, working, torque-speed characteristic and speed control of separately excited dc motor. Construction and working of synchronous generators.

Module 5: Power Converters (6 hours)

DC-DC buck and boost converters, duty ratio control. Single-phase and three-phase voltage source inverters; sinusoidal modulation.

Module 6: Electrical Installations (6 hours)

Components of LT Switchgear: Switch Fuse Unit (SFU), MCB, ELCB, MCCB, Types of Wires and Cables, Earthing. Types of Batteries, Important Characteristics for Batteries. Elementary calculations for energy consumption, power factor improvement and battery backup.

Suggested Text / Reference Books

1. Kothari, D. P. and Nagrath, I. J., Basic Electrical Engineering, Tata McGraw Hill, 2010
2. Kulshreshtha, D. C., Basic Electrical Engineering, McGraw Hill, 2009
3. Bobrow, L. S., Fundamentals of Electrical Engineering, Oxford University Press, 2011
4. Hughes, E., Electrical and Electronics Technology, Pearson, 2010
5. Toro, V. D., Electrical Engineering Fundamentals, Prentice Hall India, 1989

Subject Name: Engineering Graphics and Design **Subject Code: BTCMTESC102** **Subject Credit: 3**

Course Objectives:

Engineering Graphics and Design being the principle method of communication for engineers, the objective is to introduce the students, the techniques of constructing the various types of polygons, curves and scales. The objective is also to visualize and represent the 3D objects in 2D planes with proper dimensioning, scaling etc.

Course Outcomes:

- Introduction to engineering design and its place in society
- Exposure to the visual aspects of engineering design
- Exposure to engineering graphics standards
- Exposure to solid modelling
- Exposure to computer-aided geometric design
- Exposure to creating working drawings

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 (5 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 (5 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 (6 hours)

Regular Solids 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 (6 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 covering (6 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;

Module 6: Overview of Computer Graphics (8 hours)

Listing the computer technologies that impact on graphical communication, Demonstrating knowledge of the theory of CAD software [such as: The Menu System, Toolbars (Standard, Object Properties, Draw, Modify and Dimension), Drawing Area (Background, Crosshairs, Coordinate System), Dialog boxes and windows, Shortcut menus (Button Bars), The Command Line (where applicable), The Status Bar, Different methods of zoom as used in CAD, Select and erase objects.; Isometric Views of lines, Planes, Simple and compound Solids];

Module 7: Customization & CAD Drawing (3 hours)

Consisting of set up of the drawing page and the printer, including scale settings, Setting up of units and drawing limits; ISO and ANSI standards for coordinate dimensioning and tolerancing; Orthographic constraints, Snap to objects manually and automatically; Producing drawings by using various coordinate input entry methods to draw straight lines, Applying various ways of drawing circles;

Module 8: Annotations, layering & other functions (3 hours)

Applying dimensions to objects, applying annotations to drawings; Setting up and use of Layers, layers to create drawings, Create, edit and use customized layers; Changing line lengths through modifying existing lines (extend/lengthen); Printing documents to paper using the print command;

orthographic projection techniques; Drawing sectional views of composite right regular geometric solids and project the true shape of the sectioned surface; Drawing annotation, Computer-aided design (CAD) software modeling of parts and assemblies. Parametric and non-parametric solid, surface, and wireframe models. Part editing and two-dimensional documentation of models. Planar projection theory, including sketching of perspective, isometric, multiview, auxiliary, and section views. Spatial visualization exercises. Dimensioning guidelines, tolerancing techniques; dimensioning and scale multi views of dwelling;

Module 9: Demonstration of a simple team design project (3 hours)

Geometry and topology of engineered components: creation of engineering models and their presentation in standard 2D blueprint form and as 3D wire-frame and shaded solids; meshed topologies for engineering analysis and tool-path generation for component manufacture; geometric dimensioning and tolerancing; Use of solid-modeling software for creating associative models at the component and assembly levels; floor plans that include: windows, doors, and fixtures such as WC, bath, sink, shower, etc. Applying colour coding according to building drawing practice; Drawing sectional elevation showing foundation to ceiling; Introduction to Building Information Modelling (BIM).

Text/Reference Books:

1. Bhatt N.D., Panchal V. M. and Ingle P.R., Engineering Drawing, Charotar Publishing House, 2014
2. Shah, M. B. and Rana B.C., Engineering Drawing and Computer Graphics, Pearson Education, 2008
3. Agrawal, B. and Agrawal C. M., Engineering Graphics, TMH Publication, 2012
4. Narayana, K.L. and Kannaiah P., Textbook on Engineering Drawing, Scitech Publishers, 2008

Subject Name: Basic Electrical Engineering Lab **Subject Code: BTCMTESC101** **Subject Credit: 1**

Laboratory Objectives:

- Get an exposure to common electrical components and their ratings
- Make electrical connections by wires of appropriate ratings
- Understand the usage of common electrical measuring instruments and basic characteristics of transformers and electrical machines
- Get an exposure to the working of power electronic converters

Laboratory Outcomes:

This lab curriculum gives fundamental understanding of design of electrical instrument with targeted accuracy for physical measurements.

1. Basic safety precautions. Introduction and use of measuring instruments – voltmeter, ammeter, multi-meter, oscilloscope. Real-life resistors, capacitors and inductors.
2. Measuring the steady-state and transient time-response of R-L, R-C, and R-L-C circuits to a step change in voltage (transient may be observed on a storage oscilloscope). Sinusoidal steady state response of R-L, and R-C circuits – impedance calculation and verification. Observation of phase differences between current and voltage. Resonance in R-L-C circuits.
3. Transformers: Observation of the no-load current waveform on an oscilloscope (non-sinusoidal wave shape due to B-H curve non-linearity to be shown along with a discussion about harmonics). Loading of a transformer: measurement of primary & secondary voltages and currents & power.
4. Three-phase transformers: Star and Delta connections. Voltage and Current relationships (line-line voltage, phase-to-neutral voltage, line and phase currents). Phase-shifts between the primary and secondary side. Cumulative three-phase power in balanced three-phase circuits.
5. Demonstration of cut-out sections of machines: dc machine (commutator-brush arrangement), induction machine (squirrel cage rotor), synchronous machine (field winging - slip ring arrangement) and single-phase induction machine.
6. Torque Speed Characteristic of separately excited dc motor.
7. Synchronous speed of two and four-pole, three-phase induction motors. Direction reversal by change of phase-sequence of connections. Torque-Slip Characteristic of an induction motor. Generator operation of an induction machine driven at super-synchronous speed.
8. Synchronous Machine operating as a generator: stand-alone operation with a load. Control of voltage through field excitation.
9. Demonstration of (a) DC-DC converters (b) DC-AC converters – PWM waveform (c) the use of DC-AC converter for speed control of an induction motor and (d) Components of LT switchgear.

Subject Name: Physics Lab **Subject Code: BTCMTBSC101** **Subject Credit: 1.5**

Laboratory Objectives:

Training field-oriented Engineering graduates to handle instruments and their design methods to improve the accuracy of measurements.

Laboratory Outcomes:

Physics lab curriculum gives fundamental understanding of design of an instrument with targeted accuracy for physical measurements.

Choice of experiments from the following:

1. Experiments on electromagnetic induction and electromagnetic breaking
2. Experiments on LC circuit and LCR circuit
3. Experiments on Resonance phenomena in LCR circuits
4. Experiments on Magnetic field from Helmholtz coil
5. Measurement of Lorentz force in a vacuum tube

2nd Semester

Subject Name: Chemistry **Subject Code: BTCMTBSC201** **Subject Credit: 4**

Course Objectives:

To make the students conversant with:

- Treatment of water for domestic and industrial purpose
- Applications of different kinds of Polymers, Lubricants and adhesives
- Types and mechanism of corrosion and control measures
- Application of different types of abrasives and chemical nature of building materials and composites
- Chemistry of different types of Fuels and Explosives

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 student to:

- Analyse microscopic chemistry in terms of atomic and molecular orbitals and intermolecular forces
- Rationalise bulk properties and processes using thermodynamic considerations
- Distinguish the ranges of the electromagnetic spectrum used for exciting different molecular energy levels in various spectroscopic techniques
- Rationalise periodic properties such as ionization potential, electronegativity, oxidation states and electronegativity
- List major chemical reactions that are used in the synthesis of molecules

Module 1: Atomic and molecular structure (12 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 multicenter orbitals. Equations for atomic and molecular orbitals. Energy level diagrams of diatomics. 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 characterisation techniques. Diffraction and scattering.

Module 3: Intermolecular forces and potential energy surfaces (4 hours)

Ionic, dipolar and van Der Waals interactions. Equations of state of real gases and critical phenomena. Potential energy surfaces of H3, H2F and HCN and trajectories on these surfaces.

Module 4: Use of free energy in chemical equilibria (6 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 (4 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

Module 6: Stereochemistry (4 hours)

Representations of 3 dimensional structures, structural isomers and stereoisomers, configurations and symmetry and chirality, enantiomers, diastereomers, optical activity, absolute configurations and conformational analysis. Isomerism in transitional metal compounds

Module 7: Organic reactions and synthesis of a drug molecule (4 hours)

Introduction to reactions involving substitution, addition, elimination, oxidation, reduction, cyclization and ring openings. Synthesis of a commonly used drug molecule.

Text/Reference Books:

1. Mahan, B. H., University Chemistry
2. Sienko M. J. and Plane R. A.,Chemistry: Principles and Applications
3. Banwell C. N., Fundamentals of Molecular Spectroscopy
4. Tembe, B. L., Kamaluddin and Krishnan, M. S., Engineering Chemistry (NPTEL Web-book)
5. Atkins, P. W., Physical Chemistry
6. Volhardt, K. P. C. and Schore N. E.,Organic Chemistry: Structure and Function, 5th Edition

Subject Name: Mathematics-II **Subject Code: BTCMTBSC202** **Subject Credit: 4**

Course Objectives:

The objective of this course is to familiarize the prospective engineers with techniques in multivariate integration, ordinary and partial 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.

Course Outcomes:

The students will learn:

- The mathematical tools needed in evaluating multiple integrals and their usage
- The effective mathematical tools for the solutions of differential equations that model physical processes
- The tools of differentiation and integration of functions of a complex variable that are used in various techniques dealing engineering problems

Module 1: Multivariable Calculus (Integration): (10 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, Theorems of Green, Gauss and Stokes.

Module 2: First order ordinary differential equations: (6 hours)

Exact, linear and Bernoulli's equations, Euler'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: (8 hours)

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

Module 4: Complex Variable – Differentiation: (8 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: (8 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.

Text/Reference Books

1. Thomas, G. B. and Finney, R. L.,Calculus and Analytic Geometry, 9th Edition, Pearson, Reprint, 2002
2. Erwin Kreyszig, Advanced Engineering Mathematics, 9th Edition, John Wiley & Sons, 2006
3. Boyce,W. E. and DiPrima, R. C., Elementary Differential Equations and Boundary Value Problems, 9th Ed., Wiley India, 2009
4. Ross, S. L., Differential Equations, 3rd Ed., Wiley India, 1984
5. Coddington, E. A., An Introduction to Ordinary Differential Equations, Prentice Hall India, 1995
6. Ince, E. L., Ordinary Differential Equations, Dover Publications, 1958
7. Brown, J. W., and Churchill, R. V., Complex Variables and Applications, 7th Ed., Mc-Graw Hill, 2004
8. Bali, N. P., and Goyal, M., A text book of Engineering Mathematics, Laxmi Publications, Reprint, 2008
9. Grewal, B.S., Higher Engineering Mathematics, Khanna Publishers, 36th Edition, 2010

Subject Name: Introduction to C Programming **Subject Code: BTCMTESC201** **Subject Credit: 3**

Course Objectives:

- Formulating algorithmic solutions to problems and implementing algorithms in C
- Notion of Operation of a CPU, Notion of an algorithm and computational procedure, editing and executing programs in Linux
- Understanding branching, iteration and data representation using arrays
- Modular programming and recursive solution formulation
- Understanding pointers and dynamic memory allocation
- Understanding miscellaneous aspects of C
- Comprehension of file operations

Course Outcomes:

The student will learn:

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

Module 1:

Introduction to Programming **(4 hours)**

Introduction to components of a computer system (disks, memory, processor, where a program is stored and executed, operating system, compilers etc.) **(1 hour)**

Idea of Algorithm: steps to solve logical and numerical problems. Representation of Algorithm: Flowchart/Pseudocode with examples **(1 lecture)**

From algorithms to programs; source code, variables (with data types) variables and memory locations, Syntax and Logical Errors in compilation, object and executable code **(2 hours)**

Module 2:

Arithmetic expressions and precedence **(2 hours)**

Conditional Branching and Loops **(6 hours)**

Writing and evaluation of conditionals and consequent branching **(3 hours)**

Iteration and loops **(3 hours)**

Module 3:

Arrays **(6 hours)**

Arrays (1-D, 2-D), Character arrays and Strings

Module 4:

Basic Algorithms **(6 hours)**

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 5:

Function **(5 hours)**

Functions (including using built in libraries), Parameter passing in functions, call by value, Passing arrays to functions: idea of call by reference

Module 6:

Recursion **(4 -5 hours)**

Recursion as a different way of solving problems. Example programs, e.g. Finding Factorial, Fibonacci series, Ackerman function etc. Quick sort or Merge sort.

Module 7:

Structure **(4 hours)**

Structures, Defining structures and Array of Structures

Module 8:

Pointers **(2 hours)**

Idea of pointers, defining pointers, Use of Pointers in self-referential structures, notion of linked list (no implementation)

Module 9:

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

Text/Reference Books

1. Gottfried, B., Schaum's Outline of Programming with C, McGraw-Hill
2. Balaguruswamy, E., Programming in ANSI C, Tata McGraw-Hill
3. Kernighan,B. W. and Ritchie, D. M.,The C Programming Language, Prentice Hall of India

Subject Name: Communicative English **Subject Code: BTCMTHSMC201** **Subject Credit: 3**

Course Objectives:

- To improve the language proficiency of the students in English
- To enable the students to study and comprehend the prescribed lessons and subjects more effectively relating to their theoretical and practical components
- To develop the communication skills of the students in both formal and informal situations.

Course Outcomes:

The student will acquire basic proficiency in English including reading and listening comprehension, writing and speaking skills

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

2.1 Sentence Structures

2.2 Use of phrases and clauses in sentences

2.3 Importance of proper punctuation

2.4 Creating coherence

2.5 Organizing principles of paragraphs in documents

2.6 Techniques for writing precisely

Module 3: Identifying Common Errors in Writing

3.1 Subject-verb agreement

3.2 Noun-pronoun agreement

3.3 Misplaced modifiers

3.4 Articles

3.5 Prepositions

3.6 Redundancies

3.7 Clichés

Module 4: Nature and Style of sensible Writing

4.1 Describing

4.2 Defining

4.3 Classifying

4.4 Providing examples or evidence

4.5 Writing introduction and conclusion

Module 5: Writing Practices

5.1 Comprehension

5.2 Précis Writing

5.3 Essay Writing

Module 6: Oral Communication

(This unit 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. Michael Swan., Practical English Usage. OUP. 1995
2. Wood. F. T., Remedial English Grammar. Macmillan.2007
3. William, Z.,On Writing Well. Harper Resource Book. 2001
4. Liz Hamp-Lyons and Ben Heasly, Study Writing. Cambridge University Press. 2006
5. Sanjay Kumar and Pushp Lata, Communication Skills. Oxford University Press. 2011
6. Exercises in Spoken English. Parts. I-III. CIEFL, Hyderabad. Oxford University Press

Subject Name: Chemistry Lab **Subject Code: BTCMTBSC201** **Subject Credit: 1.5**

Laboratory Objectives:

The chemistry laboratory course will consist of experiments illustrating the principles of chemistry relevant to the study of science and engineering

Laboratory Outcomes

The students will learn to:

- Estimate rate constants of reactions from concentration of reactants/products as a function of time
- Measure molecular/system properties such as surface tension, viscosity, conductance of solutions, redox potentials, chloride content of water, etc
- Synthesize a small drug molecule and analyse a salt sample

Choice of 10-12 experiments from the following:

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. Colligative properties using freezing point depression
6. Determination of the rate constant of a reaction
7. Determination of cell constant and conductance of solutions
8. Potentiometry - determination of redox potentials and emfs
9. Synthesis of a polymer/drug
10. Saponification/acid value of an oil
11. Chemical analysis of a salt
12. Lattice structures and packing of spheres
13. Models of potential energy surfaces
14. Chemical oscillations- Iodine clock reaction
15. Determination of the partition coefficient of a substance between two immiscible liquids
16. Adsorption of acetic acid by charcoal
17. 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.

Subject Name: Introduction to C Programming **Subject Code: BTCMTESC201** **Subject Credit: 2**

Laboratory Objectives:

The laboratory course will consist of lab illustrating the principles of programming relevant to the study of science and engineering.

Laboratory Outcomes:

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

[The laboratory should be preceded or followed by a tutorial to explain the approach or algorithm to be implemented for the problem given.]

Tutorial 1: Problem solving using computers

Lab1: Familiarization with programming environment

Tutorial 2: Variable types and type conversions

Lab 2: Simple computational problems using arithmetic expressions

Tutorial 3: Branching and logical expressions

Lab 3: Problems involving if-then-else structures

Tutorial 4: Loops, while and for loops

Lab 4: Iterative problems e.g., sum of series

Tutorial 5: 1D Arrays: searching, sorting

Lab 5: 1D Array manipulation

Tutorial 6: 2D arrays and Strings

Lab 6: Matrix problems, String operations

Tutorial 7: Functions, call by value

Lab 7: Simple functions

Tutorial 8 &9: Numerical methods (Root finding, numerical differentiation, numerical integration)

Lab 8 and 9: Programming for solving Numerical methods problems

Tutorial 10: Recursion, structure of recursive calls

Lab 10: Recursive functions

Tutorial 11: Pointers, structures and dynamic memory allocation

Lab 11: Pointers and structures

Tutorial 12: File handling

Lab 12: File operations

Subject Name: Workshop Practices **Subject Code: BTCMTESC202** **Subject Credit: 3**

Course Objectives:

To impart hands-on training on basic engineering trades and skills.

Course Outcomes:

Upon completion of this course, the students will gain knowledge of the different manufacturing processes which are commonly employed in the industry, to fabricate components using different materials.

Detailed Contents

1. Manufacturing Methods- casting, forming, machining, joining, advanced manufacturing methods
2. CNC machining, Additive manufacturing
3. Fitting operations & power tools
4. Electrical & Electronics
5. Carpentry
6. Plastic moulding, glass cutting
7. Metal casting
8. Welding (arc welding & gas welding), brazing

Text/Reference Books:

1. 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.
2. Kalpakjian, S., and Steven S. S., Manufacturing Engineering and Technology, 4th edition, Pearson Education India Edition, 2002.
3. Gowri, P., Hariharan and Suresh Babu, A., Manufacturing Technology – I, Pearson Education, 2008.
4. Roy A. Lindberg, Processes and Materials of Manufacture, 4th Edition, Prentice Hall India, 1998.

Laboratory Objectives:

To impart hands-on practice on basic engineering trades and skills.

Laboratory Outcomes:

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

- Fabricate components with their own hands.
- They will also get practical knowledge of the dimensional accuracies and dimensional tolerances possible with different manufacturing processes.
- By assembling different components, they will be able to produce small devices of their interest.

Workshop Practices:

1. Machine shop **(6 hours)**

2. Fitting shop **(8 hours)**

3. Carpentry **(6 hours)**

4. Electrical & Electronics **(4 hours)**

5. Welding shop **(8 hours [Arc welding 4 hours + Gas welding 4 hours])**

6. Casting **(4 hours)**

7. Smithy **(6 hours)**

8. Plastic moulding & Glass Cutting **(3 hours)**

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

3rd Semester

Subject Name: Economics for Engineers **Subject Code: BTCMTHSMC301** **Subject Credit: 3**

On completion of the course, the students will:

- Have an idea of Economics in general, Economics of India particularly for public sector agencies and private sector businesses.
- Be able to perform and evaluate present worth, future worth and annual worth analyses on one of more economic alternatives. ¬ Be able to carryout and evaluate benefit/cost, life cycle and breakeven analyses on one or more economic alternatives.
- Be able to understand the technical specifications for various works to be performed for a project and how they impact the cost of a structure.
- Be able to quantify the worth of a structure by evaluating quantities of constituents, derive their cost rates and build up the overall cost of the structure.
- Be able to understand how competitive bidding works and how to submit a competitive bid proposal.

Module 1: Basic Principles and Methodology of Economics. Demand/Supply – elasticity – Government Policies and Application. Theory of the Firm and Market Structure. Basic Macro-economic Concepts (including GDP/GNP/NI/Disposable Income) and Identities for both closed and open economies. Aggregate demand and Supply (IS/LM). Price Indices (WPI/CPI), Interest rates, Direct and Indirect Taxes **(3 hours)**

Module 2: Public Sector Economics –Welfare, Externalities, Labour Market. Components of Monetary and Financial System, Central Bank – Monetary Aggregates; Commercial Banks & their functions; Capital and Debt Markets. Monetary and Fiscal Policy Tools & their impact on the economy – Inflation and Phillips Curve. **(2 hours)**

Module 3: Elements of Business/Managerial Economics and forms of organizations. Cost & Cost Control –Techniques, Types of Costs, Lifecycle costs, Budgets, Break even Analysis, Capital Budgeting, Application of Linear Programming. Investment Analysis – NPV, ROI, IRR, Payback Period, Depreciation, Time value of money (present and future worth of cash flows). Business Forecasting – Elementary techniques. Statements – Cash flow, Financial. Case Study Method. **(3 hours)**

Module 4: Indian economy - Brief overview of post-independence period – plans. Post reform Growth, Structure of productive activity. Issues of Inclusion – Sectors, States/Regions, Groups of people (M/F), Urbanization. Employment–Informal, Organized, Unorganized, Public, Private. Challenges and Policy Debates in Monetary, Fiscal, Social, External sectors. **(2 hours)**

Module 5: Estimation / Measurements for various items- Introduction to the process of Estimation; Use of relevant Indian Standard Specifications forthe same, taking out quantities from the given requirements of the work, comparison of different alternatives, Bar bending schedules, Mass haul Diagrams, Estimating Earthwork and Foundations, Estimating Concrete and Masonry, Finishes, Interiors, MEP works; BIM and quantity take-offs; adding equipment costs; labour costs; rate analysis; Material survey-Thumb rules for computation of materials requirement for different materials for buildings, percentage breakup of the cost, cost sensitive index, market survey of basic materials. Use of

Computers in quantity surveying **(7 hours)**

Module 6: Specifications-Types, requirements and importance, detailed specifications for buildings, roads, minor bridges and industrial structures. **(3 hours)**

Module 7: Rate analysis-Purpose, importance and necessity of the same, factors affecting, task work, daily output from different equipment/ productivity. **(3 hours)**

Module 8: Tender- Preparation of tender documents, importance of inviting tenders, contract types, relative merits, prequalification. general and special conditions, termination of contracts, extra work and Changes, penalty and liquidated charges, Settlement of disputes, R.A. Bill & Final Bill, Payment of advance, insurance, claims, price variation, etc. Preparing Bids- Bid Price buildup: Material, Labour, Equipment costs, Risks, Direct & Indirect Overheads, Profits; Bid conditions, alternative specifications; Alternative Bids. Bid process management **(6 hours)**

Module 9: Introduction to Acts pertaining to-Minimum wages, Workman's compensation, Contracts, Arbitration, Easement rights. **(1 hour)**

Term Work Assignments may include:

1. Deriving an approximate estimate for a multistoried building by approximate methods.
2. Detailed estimate for the following with the required material survey for the same.
    a. Ground plus three storied RCC Framed structure building with blockwork walls
    b. bridge with minimum 2 spans
    c. factory building
    d. road work
    e. cross drainage work
    f. Ground plus three storied building with load-

    bearing wallsg Cost of finishes, MEP works for (f)

    above.
3. Preparation of valuation report in standard Government form.
4. Assignments on rate analysis, specifications, and simple estimates.
5. Detailed estimate of minor structure.
6. Preparation of Bar bending schedule.

Text/Reference Books:

1. Mankiw Gregory N. (2002), Principles of Economics, Thompson Asia
2. V. Mote, S. Paul, G. Gupta (2004), Managerial Economics, Tata McGraw Hill
3. Misra, S.K. and Puri (2009), Indian Economy, Himalaya
4. Pareek Saroj (2003), Textbook of Business Economics, Sunrise Publishers
5. M Chakravarty, Estimating, Costing Specifications & Valuation
6. Joy P K, Handbook of Construction Management, Macmillan
7. B.S. Patil, Building & Engineering Contracts

8. Relevant Indian Standard Specifications.
9. World Bank Approved Contract Documents.
10. FIDIC Contract Conditions.
11. Acts Related to Minimum Wages, Workmen‟s Compensation, Contract, and Arbitration
12. Typical PWD Rate Analysis documents.
13. UBS Publishers & Distributors, Estimating and Costing in Civil Engineering: Theory and Practice including Specification and Valuations,2016
14. Dutta, B.N., Estimating and Costing in Civil Engineering (Theory & Practice), UBS Publishers, 2016

Subject Name: Biology **Subject Code: BTCMTBSC301** **Subject Credit: 3**

Course Objective: Students should make aware of biological basics for scientific applications.

Course Outcomes: After studying the course, the student will be able to:

- Describe biological observations of the 18th Century that lead to major discoveries.
- Convey that classification per se is not what biology is all about but highlights the underlying criteria, such as morphological, biochemical and ecological.
- Highlight the concepts of recessiveness and dominance during the passage of genetic material from parent to offspring.
- Convey that all forms of life have the same building blocks and yet the manifestations are as diverse as one can imagine Classify enzymes anddistinguish between different mechanisms of enzyme action.
- Identify DNA as a genetic material in the molecular basis of information transfer.
- Analyse biological processes at the reductionistic level
- Apply thermodynamic principles to biological systems.
- Identify and classify microorganisms.

Module 1 : Introduction Purpose: To convey that Biology is as important a scientific discipline as Mathematics, Physics and Chemistry Bring out the fundamental differences between science and engineering by drawing a comparison between eye and camera, Bird flying and aircraft. Mention the most exciting aspect of biology as an independent scientific discipline. Why we need to study biology? Discuss how biological observations of 18th Century that lead to major discoveries. Examples from Brownian motion and the origin of thermodynamics by referring to the original observation of Robert Brown and Julius Mayor. These examples will highlight the fundamental importance of observations in any scientific inquiry. **(2 hours)**

Module 2 : Classification Purpose: To convey that classification per se is not what biology is all about. The underlying criterion, such as morphological, biochemical or ecological be highlighted. Hierarchy of life forms at phenomenological level. A common thread weaves this hierarchy Classification. Discuss classification based on (a) cellularity- Unicellular or multicellular (b) ultrastructure- prokaryotes or eucaryotes. (c) energy andCarbon utilization -Autotrophs, heterotrophs, lithotropes (d) Ammonia excretion – aminotelic, uricoteliec, ureotelic

(e) Habitata- acquatic or terrestrial (e) Molecular taxonomy- three major kingdoms of life. A given organism can come under different category based on classification. Modelorganisms for the study of biology come from different groups. E.coli, S.cerevisiae, D. Melanogaster, C. elegance, A. Thaliana, M. musculus **(3 hours)**

Module 3 : Genetics Purpose: To convey that "Genetics is to biology what Newton‟s laws are to Physical Sciences" Mendel‟s laws, Concept of segregation and independent assortment. Concept of allele. Gene mapping, Gene interaction, Epistasis. Meiosis and Mitosis be taught as a part of genetics. Emphasis to be give not to the mechanics of cell division nor the phases but how genetic material passes from parent to offspring. Concepts of recessiveness and dominance. Concept of mapping of phenotype to genes. Discuss about the single gene disorders in humans. Discuss the concept of complementation using human genetics. **(4 hours)**

Module 4 : Biomolecules Purpose: To convey that all forms of life has the same building blocks and yet the manifestations are as diverse as one can imagine Molecules of life. In this context discuss monomeric units and polymeric structures. Discuss about sugars, starch and cellulose. Amino acids and proteins. Nucleotides and DNA/RNA. Two carbon units and lipids. **(4 hours)**

Module 5 : Enzymes Purpose: To convey that without catalysis life would not have existed on earth Enzymology: How to monitor enzyme catalyzed reactions. How does an enzyme catalyzereactions. Enzyme classification. Mechanism of enzyme action. Discuss at least two examples. Enzyme kinetics and kinetic parameters. Why should we know these parameters to understand biology? RNA catalysis. **(4 hours)**

Module 6 : Information Transfer Purpose: The molecular basis of coding and decoding genetic information is universal Molecular basis of information transfer. DNA as a genetic material. Hierarchy of DNA structure- from single stranded to double helix to nucleosomes. Concept of genetic code. Universality and degeneracy of genetic code. Define gene in terms of complementation and recombination. **(4 hours)**

Module 7 : Macromolecular analysis Purpose: How to analyses biological processes at the reductionistic level Proteins- structure and function. Hierarch in protein structure. Primary secondary, tertiary and quaternary structure. Proteins as enzymes, transporters, receptors and structural elements. **(5 hours)**

Module 8 : Metabolism Purpose: The fundamental principles of energy transactions are the same in physical and biological world. Thermodynamics as applied to biological systems. Exothermic and endothermic versus endergonic and exergoinc reactions. Concept of Keq and its relation to standard free energy. Spontaneity. ATP as an energy currency. This should include the breakdown of glucose to CO_2 + H_2O (Glycolysis and Krebs cycle) and synthesis of glucose from CO_2 and H_2O (Photosynthesis). Energy yielding and energy consuming reactions. Concept of Energy charge **(4 hours)**

Module 9 : Microbiology Concept of single celled organisms. Concept of species and strains. Identification and classification of microorganisms. Microscopy. Ecological aspects of single celled organisms. Sterilization and media compositions. Growth kinetics. **(3 hours)**

References:

1) Biology: A global approach: Campbell, N. A.; Reece, J. B.; Urry, Lisa; Cain, M, L.; Wasserman, S. A.; Minorsky, P. V.; Jackson, R. B. Pearson Education Ltd

2) Outlines of Biochemistry, Conn, E.E; Stumpf, P.K; Bruening, G; Doi, R.H., John Wiley and Sons

3) Principles of Biochemistry (V Edition), By Nelson, D. L.; and Cox, M. M.W.H. Freeman and Company

4) Molecular Genetics (Second edition), Stent, G. S.; and Calender, R.W.H. Freeman and company, Distributed by Satish Kumar Jain for CBSPublisher

5) Microbiology, Prescott, L.M J.P. Harley and C.A. Klein 1995. 2nd edition Wm, C. Brown Publishers

Subject Name: Mathematics - III **Subject Code: BTCMTBSC302** **Subject Credit: 4**

Course Objectives:

The objective of this course is to familiarize the students with statistical techniques. It aims to equip the students with standard concepts and tools at an intermediate to advanced level that will serve them well towards tackling various problems in the discipline.

Course Outcomes:

The students will learn:

- The ideas of probability and random variables and various discrete and continuous probability distributions and their properties.
- The basic ideas of statistics including measures of central tendency, correlation and regression.
- The statistical methods of studying data samples.

Module 1: Basic Probability (12 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 randomvariables; Expectation of Discrete Random Variables, Moments, Variance of a sum, Correlation coefficient, Chebyshev's Inequality.

Module 2: Continuous Probability Distributions (4 hours)

Continuous random variables and their properties, distribution functions and densities,normal, exponential and gamma densities.

Module 3: Bivariate Distributions (4 hours)

Bivariate distributions and their properties, *distribution of sums and quotients, condition and densities, Bayes' rule.*

Module 4: Basic Statistics (8 hours)

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.

Module 5: Applied Statistics (8 hours)

Curve fitting by the method of least squares- fitting of straight lines, second degree parabola\ and more general curves. Test of significance: Large sample test for single proportion, difference of proportions, single mean, difference of means, and difference of standard deviations.

Module 6: Small samples (4 hours)

Test for single mean, difference of means and correlation coefficients, test for ratio of variances - Chi-square test for goodness of fit and independence of attributes.

Text/References Books:

1. Kreyszig, E., Advanced Engineering Mathematics, John Wiley & Sons, 2006.
2. Hoel, P. G., Port S. C. and Stone, C. J., Introduction to Probability Theory, Universal Book Stall, 2003.
3. Ross, S., A First Course in Probability, Pearson Education India, 2002.
4. Feller, W., An Introduction to Probability Theory and its Applications, Vol. 1, Wiley, 1968.
5. Bali, N.P. and Goyal, M., A text book of Engineering Mathematics, Laxmi Publications, 2010.
6. Grewal, B.S., Higher Engineering Mathematics, Khanna Publishers, 2000.
7. Veerarajan, T., Engineering Mathematics, Tata McGraw-Hill, New Delhi, 2010.

Subject Name: Strength of Materials **Subject Code: BTCMTESC301** **Subject Credit: 3**

Course Objectives

- To impart the knowledge of the different types of stresses and strains acts on Beams.
- To acquire Knowledge on Shear force and Bending moment diagrams and shear stresses.

Course Outcomes

Upon successful completion of the course, student should be able to:

- Apply fundamental concepts of kinematics and kinetics of particles to the analysis of simple, practical problems.
- Understand measurement error and propagation of error in processed data.
- Understand basic kinematics concepts – displacement, velocity and acceleration (and their angular counterparts).
- Understand basic dynamics concepts – force, momentum, work and energy.

Course Contents

Module 1: Simple stresses and strains (9 hours)

Introduction, Definition and concept and of stress and strain. Hooke's law, Stress-Strain diagrams for ferrous and non-ferrous materials, factor of safety, Elongation of tapering bars of circular and rectangular cross sections, Elongation due to self-weight. Saint Venant's principle, Compound bars, Temperature stresses, Compound section subjected to temperature stresses, state of simple shear, Elastic constants and their relationship.

Module 2: Compound Stresses (6 hours)

Introduction, state of stress at a point, General two- and three-dimensional stress system, Principal stresses and principal planes. Mohr's circle of stresses.

Module 3: Shear Force and Bending Moments in Beams (6 hours)

Introduction to types of beams, supports and loadings. Definition of bending moment and shear force, sign conventions, relationship between load intensity, bending moment and shear force. Shear force and bending moment diagrams for statically determinate beams subjected to points load, uniformly distributed loads, uniformly varying loads, couple and their combinations.

Module 4: Bending and Shear Stresses in Beams (6 hours)

Introduction, pure bending theory, Assumptions, derivation of bending equation, modulus of rupture, section modulus, flexural rigidity. Expression for transverse shear stress in beams, Bending and shear stress distribution diagrams for circular, rectangular, 'I', and 'T' sections. Shear Centre (only concept)

Module 5: Columns and Struts (6 hours)

Introduction, short and long columns. Euler's theory; Assumptions, Derivation for Euler's Buckling load for different end conditions, Limitations of Euler's theory. Rankine-Gordon's formula for columns.

Module 6: Torsion in Circular Shaft (6 hours)

Introduction, pure torsion, Assumptions, derivation of torsion equation for circular shafts, torsional rigidity and polar modulus Power transmitted by a shaft, combined bending and torsion.

Module 7: Theories of Failure (6 hours)

Introduction, maximum principal stress theory (Rankine's theory), Maximum shearing stress theory (Tresca's theory), Strain energy theory (Beltrami and Haigh), and maximum strain theory (St. Venant's theory).

Textbooks/ Reference Books:

1. Basavarajaiah, B.S. and Mahadevappa,P., Strength of Materials in SI Units, University Press (India) Pvt. Ltd., 3rd Edition, 2010
2. Ferdinand, P., Beer, E., Russell, J. and Jr.John T. D., Mechanics of Materials, Tata McGraw-Hill, Third Edition, SI Units
3. Young,D.H., Timoshenko,S.P.,Elements of Strength of Materials, East West Press Pvt. Ltd., 5th Edition (Reprint 2014)
4. Bansal, R. K.,A Textbook of Strength of Materials, 4th Edition, Laxmi Publications, 2010
5. Rattan,S.S., Strength of Materials, McGraw Hill Education (India) Pvt. Ltd., 2nd Edition (Sixth reprint 2013)
6. Vazirani, V. N, Ratwani M. M. and Duggal,S. K.,Analysis of Structures Vol. I, 17th Edition, Khanna Publishers, New Delhi.

Subject Name: Engineering Mechanics **Subject Code: BTCMTESC302** **Subject Credit: 4**

Course Objectives:

The students completing this course are expected to understand the concepts of forces and its resolution in different planes, resultant of force system, Forces acting on a body, their free body diagrams using graphical methods. They are required to understand the concepts of centre of gravity and moments of inertia and their application, Analysis of frames and trusses, different types of motion, friction and application of work - energy method.

Course Outcomes:

Upon successful completion of the course, student should be able to:

- Apply fundamental concepts of kinematics and kinetics of particles to the analysis of simple, practical problems.
- Understand measurement error and propagation of error in processed data.
- Understand basic kinematics concepts – displacement, velocity and acceleration (and their angular counterparts).
- Understand basic dynamics concepts – force, momentum, work and energy.

Module 1: Fundamentals of Mechanics (8 hours)

Statics: Introduction to Engineering Mechanics, Units and Dimensions, Basic Mechanics, Laws of Mechanics, Representation of a Vector. Statics of particles: Force, system of forces, Resultant of forces, Equilibrium of Particles, Principle of Transmissibility of Forces, parallel forces, System of forces, moment, moment of force about line, Equilibrium of three forces in a plane, Varignon's theorem of moments, Couple.

Module 2: Equilibrium of Rigid Bodies (8 hours)

Rigid Body Equilibrium: Free body diagram, condition of equilibrium of rigid body in two dimensions, Types of beams, loads, supports, determination of support reactions, Lame's theorem.

Module 3: Introduction to Structural Mechanics (8 hours)

Structure: Structure of equilibrium: Trusses, Methods of joints and section.

Module 4: Properties of Surfaces (8 hours)

Centriod and Moment of Inertia: Centroid and center of mass: Centroids of composite plane figures and curves, Pappus and Guldinus theorem, Centre of gravity, moment of inertia, parallel axis theorem, perpendicular axis theorem, mass moment of inertia.

Module 5: Friction Force Analysis (8 hours)

Friction: Classification of friction, Laws of friction, Coefficient of friction, Limiting friction, Angle of repose, Wedge friction, Belt Friction

Module 6: Kinematics and kinetics of Particles (8 hours)

Curvilinear motion, Dynamic equilibrium, Angular momentum, Revision of Conservation of Energy, Energy and Momentum methods for Single Particle and for a System of Partic1es, Impulsive motion.

Module 7: Kinematics and kinetics of Rigid Bodies (8 hours)

General plane motion, Instantaneous center of rotation, Planer motion relative to a rotating frame, Coriolis acceleration, Frame of reference in general motion. Application of the principle of impulse and momentum to the 3D motion of a rigid body, Kinetic energy in 3D, Euler's equations of motion, Motion of a Gyroscope, Eulerian angles.

Textbooks/ Reference Books:

1. Beer, F. P. and Johnston Jr. E. R., Vector Mechanics for Engineers (In SI Units): Statics and Dynamics, 8th Edition, Tata McGraw-Hill Publishing Company, New Delhi (2004)
2. Vela Murali, Engineering Mechanics, Oxford University Press (2010)
3. Hibbeller, R. C and Gupta, A., Engineering Mechanics: Statics and Dynamics, 11th Edition, Pearson Education (2010).
4. Irving, H. S. and Rao. K. M. G., Engineering Mechanics-Statics and Dynamics, 4thEdition, Pearson Education (2006)
5. Meriam, J. L. and Kraige, L. G., Engineering Mechanics-Statics - Volume 1, Dynamics- Volume 2,3rd Edition, John Wiley & Sons,(1993)
6. Rajasekaran, S and Sankarasubramanian, G., Engineering Mechanics Statics and Dynamics, 3rdEdition, Vikas Publishing House, (2005).
7. Bhavikatti, S. S and Rajashekarappa, K. G., Engineering Mechanics, New Age International (P) Limited Publishers, (1998).
8. Kumar, K. L., Engineering Mechanics, 3rd Revised Edition, Tata McGraw-Hill Publishing Company, New Delhi (2008)

Subject Name: Introduction to Materials Science **Subject Code: BTCMTPCC301** **Subject Credit: 3**

Course Objectives:

To provide the students with basic knowledge of materials science, so that they would be able to understand the difference between variety of materials based on their structure and properties.

Course outcome:

Students will get to know the different classes of materials used in engineering applications and would be able to choose the right materials for specific applications.

Course Contents

Module I

Structure of solids: Introduction to engineering materials, Description of materials science tetrahedron, Force - interatomic distance curve, Structure - description of unit cell and space lattices, Coordination number, APF for cubic and hexagonal close packed structures, Miller indices, Non crystalline structures properties of crystalline and amorphous structures, Crystal imperfections Significance of structure property correlations in all classes of engineering materials. **(8 hours)**

Module II

Diffusion phenomenon: Diffusion in ideal solutions, Kirkendall effect, Rate and mechanism of diffusion, Fick's first and second law of diffusion, Applications of diffusion, Concept of uphill diffusion,

Principles of solidification and phase equilibria: Concept of free energy and entropy; Structure of liquid metals; Energetics of solidification; Nucleation and growth, Homogeneous and heterogeneous nucleation, Dendritic/Equiaxed growth, Origination of grain and grain boundaries, Cast structure; Significance of alloying, Intermediate alloy phases, solid solutions and its types **(8 hours)**

Module III

Phase diagrams and phase transformations: Basic definitions; Gibbs phase rule, Introductions to binary, ternary and Quaternary system; Construction of binary isomorphous diagram from cooling curves, Time scale for phase diagrams, Transformations in steels, Precipitation process, re-crystallization and growth.

Heat treatment: TTT curves, CCT curves, Annealing, Normalizing, Hardening, Tempering **(10 hours)**

Module IV

Ceramics: Introduction to ceramic materials; Classification of ceramics, Crystal structure and bonding of common advanced ceramic materials; Mechanical behavior of ceramics, Glass and glass ceramics, Preparation and characterization of ceramics powders; Characterization of ceramic materials; Applications of ceramics in advanced technologies **(8 hours)**

Module V

Introduction to thermal properties, thermal conductivity, thermal properties of different materials, Thermal fatigue, Magnetic properties Basic of Magnetism, Diamagnetism, Ferromagetic behaviousr, Superconductivity, , Electrical Properties, Optical Properties **(11 Hours)**

Books:

1. R. Abbaschian, R.E. Reed-Hill, Physical Metallurgy Principles, 4th ed., Cengage Learning, 2009.
2. D.R. Askeland, P.P. Phule, W.J. Wright, The Science and Engineering of Materials, 6th ed., Cengage Learning, 2010.
3. W.D. Callister, D.G. Rethwisch, Materials science and Engineering: An Introduction, 8th ed., Wiley, 2010.
4. B.S. Mitchell, An Introduction to Materials Engineering and Science for Chemical and Materials Engineers, 1st ed., Wiley- Interscience, 2003.
5. C. Kittel, Introduction to Solid State Physics, 8th ed., Wiley, 2005.
6. V. Singh, Physical Metallurgy, 1st ed., 2008.
7. S.H. Avener, Introduction to Physical Metallurgy, 2nd ed., Tata McGraw-Hill Education, 2011.
8. V. Raghavan, Materials Science & Engineering: A first course, 5th ed., PHI Learning, 2004
9. W.D. Kingery, Introduction to Ceramics, 2nd edition, John Wiley & sons, 1999.

Subject Name: Materials Thermodynamics Subject Code: BTCMTPCC302 Subject Credit: 3

Course Objectives

To highlight the fundamental role of principles of thermodynamics in describing metallurgical and materials processes as well as to learn and use thermodynamic functions, rules and relations and interpret thermodynamic plots and diagrams.

Course Outcomes

After completing this course, the student should be able to:

Able to interpret the fundamental aspects of thermodynamics related to general principles of matter.

Able to predict behavior of matters based on thermodynamic principles as it undergoes various changes in condition.

Able to use the various thermodynamic functions appropriately under different experimental and industrial situations involving gases, liquids and solids.

Able to design new processes and improve the existing ones.

Able to create materials with desired properties.

Able to derive relationship among the properties of matter.

Able to solve problems of practical interest using thermodynamic equations.

Able to understand and apply the principles of solution thermodynamics in various high temperature metallurgical phenomena.

Course Contents

Module 1: Introduction, Ideal Gas, Energy and Work, System, Extensive and Intensive Properties **(3 hours)**

Module 2: First Law of Thermodynamics, Internal Energy, Enthalpy, Heat Capacity, Reversible Processes **(4 hours)**

Module 3: Second Law of Thermodynamics, Entropy and equilibrium, Reversibility, Heat Engines **(3 hours)**

Module 4: Statistical Interpretation of Entropy, Boltzmann Equation, Entropy and its correlations with other thermodynamic functions **(3 hours)**

Module 5: Auxiliary Functions Enthalpy, Free Energy, Chemical Potential, Maxwell's Equations, Gibbs-Helmholtz Equation **(4 hours)**

Module 6: Enthalpy as a Function of Temperature and Composition, Third Law of Thermodynamics **(3 hours)**

Module 7: Phase Equilibrium in a One-Component System, Equilibrium between Vapor and Condensed Phase, and between condensed phases **(3 hours)**

Module 8: Gases: Ideal, Real, van der Waals **(3 hours)**

Module 9: Roult's Law and Henry's Law, Activity, Gibbs-Duhem Equation, Properties of Ideal and Non-ideal Solutions, Regular Solutions, Sievert's Law **(3 hours)**

Module 10: Activity, Phase Diagrams of some Binary Systems **(3 hours)**

Module 11: Effect of Temperature and Pressure on the Equilibrium Constant for a gas mixture **(3 Hours)**

Module 12: Ellingham Diagrams, interpretations and applications **(3 hours)**

Module 13: The Gibbs Phase Rule **(3 hours)**

Module 14: Electrochemistry, Concentration and EMF, Standard Reduction Potentials, Pourbaix Diagrams **(4 hours)**

Suggested Books

- Introduction to Thermodynamics of Materials by D R Gaskell, Taylor and Francis, 2016
- Materials Thermodynamics with Emphasis on Chemical Approach by Hae-Geon Lee, World Scientific Publishing, 2012
- Textbook of Materials and Metallurgical Thermodynamics by A Ghosh, PHI Learning Pvt Ltd, 2018
- Principles of Metallurgical Thermodynamics by S K Bose and S K Roy, Universities Press, 2014
- Thermodynamics in Materials Science by Robert DeHoff, CRC Press, 2006.

Subject Name: Environmental Sciences (Mandatory Course) Subject Code: BTCMTMC301 Subject Credit: Non-credit Course

We as human being are not an entity separate from the environment around us rather, we are a constituent seamlessly integrated and co-exist with the environment around us. We are not an entity so separate from the environment that we can think of mastering and controlling it rather we must understand that each and every action of ours reflects on the environment and vice versa. Ancient wisdom drawn from Vedas about environment and its sustenance reflects this ethos. There is a direct application of this wisdom even in modern times. The idea of an activity-based course on environment protection is to sensitize the students on the above issues through following two types of activities.

Awareness Activities:

i. Small group meetings about water management, promotion of recycle use, generation of less waste, avoiding electricity waste
ii. Slogan making event
iii. Poster making event
iv. Cycle rally
v. Lectures from experts

Actual Activities:

i. Plantation
ii. Gifting a tree to see its full growth.
iii. Cleanliness drive
iv. Drive for segregation of waste.
v. To live some big environmentalist for a week or so to understand his work.
vi. To work in kitchen garden for mess
vii. To know about the different varieties of plants
viii. Shutting down the fans and ACs of the campus for an hour or so

Innovation

4th Semester

Subject Name: Universal Human Values II: Understanding Harmony Subject Code: BTCMTHSMC401 Subject Credit: 3

This course discusses the student's role in their family. It, very briefly, touches issues related to their role in the society and the nature, which needs to be discussed at length in one more semester for which the foundation course named as "Universal Human Values-II: Understanding Harmony" is designed which is covered in IV semester. During the Induction Program, students would get an initial exposure to human values through Universal Human Values – I. This exposure is augmented by this compulsory full semester foundation course.

Course Objectives:

The objective of the course is fourfold:

- Development of a holistic perspective based on self-exploration about themselves (human being), family, society and nature/existence.
- Understanding (or developing clarity) of the harmony in the human being, family, society and nature/existence.
- Strengthening of self-reflection.
- Development of commitment and courage to act.

Course Outcomes:

By the end of the course, students are expected to become more aware of themselves, and their surroundings (family, society, nature); they would become more responsible in life, and in handling problems with sustainable solutions, while keeping human relationships and human nature in mind. They would have better critical ability. They would also become sensitive to their commitment towards what they have understood (human values, human relationship and human society). It is hoped that they would be able to apply what they have learnt to their own self in different day-to-day settings in real life, at least a beginning would be made in this direction. This is only an introductory foundational input. It would be desirable to follow it up by:

a) faculty-student or mentor-mentee programs throughout their time with the institution.

b) Higher level courses on human values in every aspect of living. e.g. as a professional.

The course has 28 lectures and 14 practice sessions in 5 modules:

Module 1: Course Introduction - Need, Basic Guidelines, Content and Process for Value Education

1. Purpose and motivation for the course, recapitulation from Universal Human Values-I
2. Self-Exploration–what is it? - Its content and process; 'Natural Acceptance' and Experiential Validation- as the process for self-exploration
3. Continuous Happiness and Prosperity - A look at basic Human Aspirations
4. Right understanding, Relationship and Physical Facility- the basic requirements for fulfillment of aspirations of every human being with their correct priority
5. Understanding Happiness and Prosperity correctly- A critical appraisal of the current scenario
6. Method to fulfil the above human aspirations: understanding and living in harmony at various levels.

Practice sessions should be included to discuss natural acceptance in human being as the innate acceptance for living with responsibility (living in relationship, harmony and co-existence) rather than as arbitrariness in choice based on liking-disliking

Module 2: Understanding Harmony in the Human Being - Harmony in Myself!

7. Understanding human being as a co-existence of the sentient 'I' and the material 'Body'
8. Understanding the needs of Self ('I') and 'Body' - happiness and physical facility
9. Understanding the Body as an instrument of 'I' (I being the doer, seer and enjoyer)
10. Understanding the characteristics and activities of 'I' and harmony in 'I'
11. Understanding the harmony of I with the Body: Sanyam and Health; correct appraisal of Physical needs, meaning of Prosperity in detail
12. Programs to ensure Sanyam and Health.

Practice sessions should be included to discuss the role others have played in making material goods available to me. Identifying from one's own life. Differentiate between prosperity and accumulation. Discuss program for ensuring health vs dealing with disease.

Module 3: Understanding Harmony in the Family and Society- Harmony in Human-Human Relationship

13. Understanding values in human-human relationship; meaning of Justice (nine universal values in relationships) and program for its fulfilment to ensure mutual happiness; Trust and Respect as the foundational values of relationship.
14. Understanding the meaning of Trust; Difference between intention and competence
15. Understanding the meaning of Respect, Difference between respect and differentiation; the other salient values in relationship
16. Understanding the harmony in the society (society being an extension of family): Resolution, Prosperity, fearlessness (trust) and co-existence as comprehensive Human Goals

17. Visualizing a universal harmonious order in society- Undivided Society, Universal Order- from family to world family.

Practice sessions should be included to reflect on relationships in family, hostel and institute as extended family, real life examples, teacher-student relationship, goal of education etc. Gratitude as a universal value in relationships. Discuss scenarios. Elicit examples from students' lives.

Module 4: Understanding Harmony in Nature and Existence - Whole existence as Coexistence.

18. Understanding the harmony in the Nature
19. Interconnectedness and mutual fulfillment among the four orders of nature- recyclability and self-regulation in nature
20. Understanding Existence as Co-existence of mutually interacting units in all-pervasive space
21. Holistic perception of harmony at all levels of existence.

Practice sessions should be included to discuss human beings as cause of imbalance in nature (film "Home" can be used), pollution, depletion of resources and role of technology etc.

Module 5: Implications of the above Holistic Understanding of Harmony on Professional Ethics

22. Natural acceptance of human values
23. Definitiveness of Ethical Human Conduct
24. Basis for Humanistic Education, Humanistic Constitution and Humanistic Universal Order
25. Competence in professional ethics: a. Ability to utilize the professional competence for augmenting universal human order b. Ability to identify the scope and characteristics of people friendly and eco-friendly production systems, c. Ability to identify and develop appropriate technologies and management patterns for above production systems.
26. Case studies of typical holistic technologies, management models and production systems
27. Strategy for transition from the present state to Universal Human Order: a. At the level of individual: as socially and ecologically responsible engineers, technologists and managers b. At the level of society: as mutually enriching institutions and organizations
28. Sum up.

Practice Exercises should be included, and Case Studies will be taken up in Practice (tutorial) Sessions e.g. to discuss the conduct as an engineer or scientist etc.

Text/Reference Books

1. Gaur, R. R., Sangal, R., Bagaria, G. P., Human Values and Professional Ethics, Excel Books, New Delhi, 2010
2. Nagaraj, A., Jeevan Vidya: Ek Parichaya, Jeevan Vidya Prakashan, Amarkantak, 1999.
3. Tripathi, A. N., Human Values, New Age Intl. Publishers, New Delhi, 2004.
4. The Story of Stuff (Book).
5. Gandhi, M. K., The Story of My Experiments with Truth
6. Schumacher, E. F, Small is Beautiful
7. Andrews, C., Slow is Beautiful
8. Kumarappa, J. C., Economy of Permanence
9. Pandit Sunderlal, Bharat Mein Angreji Raj
10. Dharampal, Rediscovering India
11. Gandhi, M. K., Hind Swaraj or Indian Home Rule
12. Azad, M. A. K., India Wins Freedom
13. Rolland, R., The Life of Vivekananda
14. Rolland, R., Gandhi - (English)

Mode of Conduct:

Lectures hours are to be used for interactive discussion, placing the proposals about the topics at hand and motivating students to reflect, explore and verify them.

Tutorial hours are to be used for practice sessions.

While analyzing and discussing the topic, the faculty mentor's role is in pointing to essential elements to help in sorting them out from the surface elements. In other words, help the students explore the important or critical elements.

In the discussions, particularly during practice sessions (tutorials), the mentor encourages the student to connect with one's own self and do self-observation, self-reflection and self-exploration. Scenarios may be used to initiate discussion. The student is encouraged to take up" ordinary" situations rather than" extra-ordinary" situations. Such observations and their analyses are shared and discussed with other students and faculty mentor, in a group sitting.

Tutorials (experiments or practical) are important for the course. The difference is that the laboratory is everyday life, and practical are how you behave and work in real life. Depending on the nature of topics, worksheets, home assignment and/or activity are included. The practice sessions (tutorials) would also provide support to a student in performing actions commensurate to his/her beliefs. It is intended that this would lead to development of commitment, namely behaving and working based on basic human values.

It is recommended that this content be placed before the student as it is, in the form of a basic foundation course, without including anything else or excluding any part of this content. Additional content may be offered in separate, higher courses.

This course is to be taught by faculty from every teaching department, including HSS faculty. Teacher preparation with a minimum exposure to at least one 8-day FDP on Universal Human Values is deemed essential.

Assessment:

This is a compulsory credit course. The assessment is to provide a fair state of development of the student, so participation in classroom discussions, self-assessment, peer assessment etc. will be used in evaluation.

Example:

Assessment by faculty mentor: 10 marks

Self-assessment: 10 marks

Assessment by peers: 10 marks

Socially relevant project/Group Activities/Assignments: 20 marks

Semester End Examination: 50 marks

The overall pass percentage is 40%. In case the student fails, he/she must repeat the course.

Subject Name: Physical Metallurgy **Subject Code: BTCMTPCC401** **Subject Credit: 4**

Objectives of the course

To learn about the principles of alloy design, phase diagram and strengthening mechanisms in different metals and alloys.

To study the fundamental aspects of heat treatment and its influence on properties and applications

To obtain knowledge about the physical metallurgy of specific and important engineering materials such as ferrous and non-ferrous alloys

Course Outcomes

By completing this course, the student will have:

The ability to identify the concepts of alloy design, phase diagrams and strengthening mechanisms and apply them to materials systems

The knowledge of heat treatment and the resulting microstructure in materials

The knowledge of physical metallurgical aspects of important engineering alloys

Detailed contents

Module 1: Introduction, Atomic structure of materials, Symmetry aspects in crystals, crystal systems, crystal planes and directions, atomic packing efficiency, voids in common crystal systems, principles of alloying, Hume-Rothery rules, Solidification of pure metal, Homogeneous and heterogeneous nucleation processes, cooling curve, concept of super cooling, microstructures of pure metals, solidification of metal in ingot mold. Crystal imperfections **(10 hours)**

Module 2: Mechanical properties of metals, concept of plastic deformation of metals, Slip and twinning Concept of cold working: Recovery; Recrystallization and grain growth; Hot working. Concept of equilibrium, Concept of alloy formation, types of alloys, solid solutions, factors governing solid solubility; Phase and Phase diagram, phase rule, Unary phase diagram, binary phase diagrams, ternary phase diagrams; Free energy composition curves for binary system **(10 hours)**

Module 3: Iron cementite and iron- graphite phase diagrams; Effect of common alloying elements on the Fe-Fe3C; TTT, Isothermal and CCT diagram; influence of alloying elements on transformation, characteristics; Isomorphous, Eutectic, Peritectic, Eutectoid, Peritectoid, Monotectic and Monotectoid system, Lever rule and its application, interpretation of solidification behavior and microstructure of different alloys belonging to those systems, effect of non-equilibrium cooling, coring and homogenization **(9 hours)**

Module 4: Concept of heat treatment of steels i.e., annealing, normalizing, hardening, and tempering; Concept to hardenability; factors affecting hardenability; Microstructural effects brought about by these processes and their influences on mechanical properties **(6 hours)**

Module 5: Microstructure and properties of different alloys (both steels and cast irons); Alloy Steels- Stainless steels; Superalloys, shape memory alloys. Physical metallurgy of non-ferrous alloys: aluminum alloys, titanium alloys, copper base alloys **(5 hours)**

PHYSICAL METALLURGY LABORATORY

1. Study and use of metallurgical microscope.
2. Metallographic specimen preparation, mechanical polishing, mounting, and etching.
3. Microstructure of annealed pure metals-iron, copper, lead, zinc aluminum and use of specific etchants.

4. Macro etching and Sulphur printing.
5. Electro polishing.
6. Calibration of thermocouple.
8. Comparative study of microstructure of annealed steel (Hypo-eutectoid, Eutectoid, Hype-eutectoid) and variation of hardness.
9. Microstructure of Cast Iron (Gray, White, Nodular).
10. Microstructure of eutectic alloys Al-Si, Pb-Sn, and Pb-Sb.
11. Microstructure of wrought and annealed single-phase alpha brass & Aluminum.
12. Study on Recovery, Recrystallisation and Grain growth of cold worked copper.

Suggested books:

Physical Metallurgy: Principles and Practice, V. Raghavan, PHI Learning, Delhi, 2008.

Physical Metallurgy Principles, R. Abbaschian, R. E. Reed-Hill, Cengage Learning, 2009

Suggested reference books

Physical Metallurgy Vols. I, II, III, R.W. Cahn and P. Haasen, North Holland, 1996.

Light Metals, I.J. Polmear, Elsevier, 2005

Subject Name: Principles of Extractive Metallurgy Subject Code: BTCMTPCC402 Subject Credit: 3

Course Objectives

To provide the students a comprehensive overview of the embedded principles associated with various routes of extraction of metals

Course Outcomes

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

- Analyze a process of metal extraction based on the underlying fundamental principles
- Design a process flowsheet for the extraction of a metal
- Critically analyze and evaluate the effects of process parameters affecting metal extraction

Course Contents

- **Module 1:** Mineral beneficiation and its importance, size reduction, Rittinger's Law and Kick's Law, selection, breakage and classification function, estimation of particle size distributions, minimum sample size for ground material, slurry processing and transportation, slurry

characterization, metallurgical accounting and control, analysis of mineral processing flow sheets involving slurry streams, principles and practice of flotation, flotation circuits, floatation columns **(8 hours)**

- **Module 2:** Outline and general principles of heat and mass balance, laminar and turbulent flow, boundary layer theory, friction factor, heat and mass transfer coefficients and dimensionless numbers **(6 hours)**
- **Module 3:** Fluid flow and heat transfer in packed and fluidized bed, heat and mass transfer of moving boundary problems involving melting, solidification and reactions, radiative heat exchange in transparent and absorbing media **(6 hours)**
- **Module 4:** Unit Processes in pyrometallurgy, drying, calcination, roasting, pelletizing and sintering, thermodynamic principles of metal extraction, slags, reduction smelting in shaft furnace, alternative reductants, hydrogen as reductant, metallothermic reduction; reactor design considerations, fluidized and fixed bed metallurgical reactors **(8 hours)**
- **Module 5 :** Kinetics of metallurgical processes, empirical rate laws **(3 hours)**
- **Module 6 :** Thermodynamic principles and applications of matte smelting and converting, flash smelting and submerged bath smelting. Principles of metal refining for metals like copper, nickel, titanium, and zinc. Unit processes in hydrometallurgy: leaching, purification of leach liquor, solvent extraction and ion exchange systems and flow sheet design **(8 hours)**
- **Module 7 :** Unit processes in electrometallurgy: Faraday's laws of electrolysis, concept of overvoltage, limiting current density, overall cell voltage, series and parallel electrical circuits in refining. Electrowinning & electrorefining with reference to metals like Cu, Zu, Al, Mg **(6 hours)**

Suggested Books

- Principles of Extractive Metallurgy by Terkel Rosenqvist, McGraw-Hill International, 1983
- Unit Processes of Extractive Metallurgy by R D Pehlke, Elsevier publishing Company, 1973
- Principles of Extractive Metallurgy by H S Ray and A Ghosh, New Age International Publishers, 2019.

Subject Name: Mechanical Metallurgy **Subject Code: BTCMTPCC403** **Subject Credit: 4**

Course Objectives:

To impart basic knowledge on the response of the materials under static/dynamic loading at different temperatures

Course Outcomes:

The students will have insights on the basic deformation behavior of various materials

They will be able to make the right choice of material for a given loading conditions

Course Contents:

Module I : Concept of stresses and strains, Engineering stresses and strains, Different types of loading and temperature encountered in applications, Tensile Test- stress-strain response for metal, Ceramic and polymer, Elastic region, Yield criteria, Yield point, Plastic deformation, Necking and

fracture, Bonding and Material behavior; Theoretical estimates of yield strength in metals and ceramics, Mechanical properties of materials in small dimensions-nano indentation **(12 hours)**

Module II : Crystals and defects, Classification of defects, thermodynamics of defects, Geometry of dislocations, Concepts of plastic deformation by slip and twinning, Slip systems in FCC, BCC and HCP lattices, Critical resolved shear stress for slip, Theoretical shear strength of solids, Stacking faults and deformation bands; Observation of dislocations, Climb and cross slip, Dislocations in FCC and HCP lattice, Partial dislocations, Stress fields and energies of dislocations, Forces between dislocations, Interaction of dislocations, Dislocation sources and their multiplications, Frank Read and grain boundary sources, dislocations in ceramics and glasses Strengthening from grain boundaries, Grain size measurements, Yield point phenomenon, Strain aging, Solid solution strengthening, Strengthening from fine particles, Fiber strengthening, Cold working and strain hardening, Annealing of cold worked metal **(13 hours)**

Module III : Fracture in ceramics, Polymers and metals, Different types of fractures in metals, Fracture mechanics- linear fracture mechanics- K_{IC}, elasto-plastic fracture mechanics-J_{IC}, Measurement and ASTM standards, Design based on fracture mechanics, Effect of environment, Effect of microstructure on K_{IC} and J_{IC}, Application of fracture mechanics in the design of metals, Ceramics and polymers **(12 hours)**

Module IV : S-N curves, Low and high cycle fatigue, Life cycle prediction, Fatigue in metals, Ceramics and polymers; Effect of stress concentration on fatigue, Size effect, Surface effects and fatigue, Creep and stress rupture, Creep curve, Stress rupture test, Mechanism of creep deformation, Activation energy for steady state creep, Superplasticity, Fracture at elevated temperature, Creep resistant alloys, Creep under combined stresses **(11 hours)**

Mechanical Metallurgy Laboratory:

Brinell Hardness Test of Specimen, Rockwell Hardness Test of Specimen, Vicker Hardness test of Specimen, Tensile and Compression testing, S/N Curve of Specimen **(30 hours)**

Textbooks:

1. G.E. Dieter, Mechanical Metallurgy, 2nd ed., McGraw-Hill, 1976.

2. R.W. Hertzberg, Deformation and Fracture Mechanics of Engineering Materials, John Wiley & Sons, 1989.

3. J. Roesler, H. Harders, M. Baeker, Mechanical Behaviour of Engineering Materials: Metals, Ceramics, Polymers, & Composites, Springer-Verlag, 2007.

References:

1. T. H. Courtney, Mechanical Behavior of Materials, McGraw-Hill, 1990.

2. R. Hill, E. Robert, Physical Metallurgy Principles, 2nd ed., East West Press, 1972.

3. W.M. Hyden, W.G. Moffatt, Structure and Properties of Materials, Vol. 3, McGraw Hill

4. M.A. Meyers, K.K. Chawla, Mechanical Behavior of Materials, 2nd ed., Cambridge University Press, 2009.

5. W.F. Hosford, Mechanical Behavior of Materials, Cambridge University Press, 2005.

6. R.W.K. Honeycombe, Plastic deformation of Metals, 2nd ed., Edward Arnold Press, 1984.

Subject Name: Fundamentals of Non-ferrous Metals **Subject Code: BTCMTPEC401** **Subject Credit: 3**

Course objective: To gather knowledge about the structure, properties and applications of various non-ferrous metals and alloys and their importance.

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

- Understand the fundamental aspects of various important non-ferrous metals and alloys including Al , Al alloys, Cu, Cu alloys, Titanium, Lead , Nickel, Zinc and other important non-ferrous metals and alloys

Course Content:

Module 1: Introduction.	4 hours
Module 2: Aluminium and its alloys	10 hours
Module 3: Copper and its alloys	10 hours
Module 4: Magnesium, Nickel, Lead and their alloys	8 hours
Module 5: Tin, Titanium, Zinc and their alloys	8 hours

Suggested reading:

2. Introduction to Physical Metallurgy by Sidney H Avner.

Subject Name: Light Metals and Alloys **Subject Code: BTCMTPEC402** **Subject Credit: 3**

Course objective: To study the structure, processing and properties of various Light Metals and Alloys.

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

- Establish correlation between microstructure and mechanical properties of various light metals and alloys
- Acquire knowledge about various processing techniques of light metals and alloys

Course Content:

Module 1: Introduction; Importance of light metals and alloys (**2 hours)**

Module 2: Different methods of synthesis of light-weight metallic materials: ingot metallurgy, semi-solid processing, spray deposition, mechanical alloying, plasma processing, vapor deposition, and electron beam processing **(8 hours)**

Module 3: Ti: Production of Ti; processing, properties, and applications (aerospace and others) of Ti-alloys **(8 hours)**

Mg: Production of Mg; melting and casting; recent development of Mg alloys; applications (aerospace, automobile, and others) **(8 hours)**

Al: Production of Al; wrought Al-alloys; cast Al-alloys; applications (aerospace and others) **(8 hours)**

Module 4: New materials and processing methods: metal (Al, Mg, Ti)–matrix composites; rapid solidification processing; amorphous alloys; mechanical alloying; nanophase alloys; titanium aluminides; foams (**6 hours)**

Suggested reading:

1. I. J. Polmear, Light Alloys, Butterworth Heinemann, Fourth Edition

2. Semisolid Processing of Alloys edited by Kirkwood.

Subject Name: Mineral Processing **Subject Code: BTCMTOEC401** **Subject Credit: 3**

Course objective: To impart fundamental understanding of various unit operations in mineral processing.

Course outcome: At the end of the course, the students would understand the various unit operations, equipment, and beneficiation techniques for processing of the minerals.

MODULE 1: Introduction : Necessity, scope, importance of mineral processing. Important definitions: ore, mineral, gangue, concentrate, tailing, yield, recovery and ratio of concentration etc. Properties of different minerals relevant to their processing **(4 hours)**

MODULE 2: Properties of Solids and their Handling : Particle size, shape, specific surface area, density, shape factor, screen analysis, different types of screens – static and dynamic, screening surfaces and screen efficiency, factors influencing screen efficiency. Standard screen series, estimation of average particle size, differential and cumulative particle size analysis, sampling of coal and minerals. Fundamentals of size reduction, comminution laws, different types of crushers and grinding mills, their features and application. Liberation of minerals, degree of liberation **(10 hours)**

MODULE 3: Fluid-Particle Interaction: Movements of solids in fluid, Laws of settling, free settling, hindered settling. Classification- types of classifiers, their principles and operations **(4 hours)**

MODULE 4: Gravity Separation: Different types of gravity separation-Principles, units, applications of dense media, Jigs, flowing film concentrators, cyclones **(8 hours)**

MODULE 5: Magnetic and Electrostatic Separation: Magnetic and electrostatic separation: Principles, different types of magnetic and electrical separators, their features, and applications **(5 hours)**

MODULE 6: Froth Flotation & Dewatering: Flotation theory, double layer of solid-liquid interface, zeta potential. Physics and chemistry of interfaces, surface energy, interfacial tension, and its role in flotation. Flotation reagents and their importance. Characteristics of minerals and reagents, flotation applications in coal and minerals. Dewatering – Flocculation, Thickening, filtration and drying. Leaching and extraction **(12 Hours)**

MODULE 7: Alternate Beneficiation Techniques: Selective flocculation, Oil agglomeration, Fluidization, and other modern beneficiation techniques. Recent developments **(2 hours)**

Textbook:

- Mineral Processing Technology (B. A. Wills)
- Introduction to Mineral Processing (Kelly and Spottiswood)
- Principles of Mineral Dressing (A. M. Gaudin)
- Ore Processing by S K Jain
- Operational Handbook of Mineral Processing by Vedula V Ramana Murty
- Mineral Processing by M R Pryor
- Progress in Mineral Processing Technology by Halim Demirel and Ankara Turkey Salih Ersayin

Subject Name: Chemical Processing **Subject Code: BTCMTOEC402** **Subject Credit: 3**

Course Objectives:
To discuss the fundamental aspects and various chemical processing methods to make the students familiar with the various processes of metal extraction.

Course Outcomes:
At the end of the course, the students are expected to understand the subject and practice in the regular mineral processing and metal extraction industries without the aid of chemical engineers.

Course Contents:
Module 1: Unit Processes: Unit processes of chemical processing (Definition, Classifications, Control factors, Types of reactors, Continuous vs batch processes) **(8 hours)**

Module 2: Leaching Practices: Leaching with various solvents for solid-liquid interaction with reference to U, Al, Th, Zr, etc (Definition, Types of leaching, Parameters, Reactors, Control, Application in specific metals) **(9 hours)**

Module 3: Leaching Parameters: Effect of various parameters on rate of leaching, Reaction models **(5 hours)**

Module 4: Rate Controlling Steps: Determination of rate controlling step in process design **(4 hours)**

Module 5: Separation Practices: Solid-Liquid separation practices **(6 hours)**

Module 6: Recovery Practices: Recovery of valuable fraction for solution **(4 hours)**

Module 7: Enrichment Treatment and Metal Recovery: Enrichment treatment of solvent like – solvent extraction, ion exchange, precipitation technique, metal recovery from solvent and solid fraction **(9 hours)**

Suggested Books:

- Principles of Extractive Metallurgy by H S Ray and A Ghosh, New Age International Publishers, 2019
- Principles of Extractive Metallurgy, T Rosenqvist, McGraw Hill Book Co.
- Handbook of Extractive Metallurgy, Fathi Habashi, Wiley-VCH

5th Semester

Subject Name: Phase Transformations **Subject Code: BTCMTPCC501** **Subject Credit: 4**

Objectives of the course:

To introduce the student to key concepts in Phase transformations and enable an understanding of the steps involved in several important phase transformations.

Course Outcomes:

After completing this course, the student should be able to: Classify phase transformations.

Indicate important steps in different types of phase transformations.

Explain phase transformations from the perspective of thermodynamics and kinetics.

Describe a few well known and studied phase transformations.

Course Contents:

Module 1: Introduction: Basic concepts about Stability of Phases and equilibrium; Definition and types of Phase transformations, Order of transformations. Phase Equilibria: Thermodynamics of phase changes, phase diagrams and equilibria in relation to Free energy-composition diagrams. **(5 hours)**

Module 2: Diffusion: Fick's laws of diffusion, solution of Fick's second law and its applications, atomic model of diffusion and role of crystal defects, temperature dependence of diffusion coefficient **(5 hours)**

Module 3: Kirkendall effect. Diffusional transformation in solids and diffusionless transformation in solids **(2 hours)**

Module 4: Nucleation and growth - energy considerations; homogeneous nucleation, heterogeneous nucleation, growth kinetics, overall transformation rates **(4 hours)**

Module 5: Crystal interfaces and microstructure. Microstructure evolution including recrystallization and grain growth **(4 hours)**

Module 6: Precipitation from solid solution: Homogeneous and hetrogeneous nucleation of precipitates, the aging curve, mechanisms of age hardening, examples from Al-Cu and other alloy systems **(5 hours)**

Module 7: Solid State Phase Transformations in steel: Reconstructive and displacive transformations; Pearlitic transformation: mechanism and kinetics; Bainitic transformation: mechanism and kinetics; morphology of upper bainite and lower bainite; Martensitic transformation: Mechanism- diffusionless displacive nature; morphology of high carbon and low carbon martensite; crystallography and kinetics of martensitic transformations **(9 hours)**

Module 8: Order-disorder Transformation Examples of ordered structures, long and short-range order, detection of super lattices, influence of ordering on properties; Spinodal decomposition **(6 hours)**

Phase Transformation Laboratory

Experiment 1: Measurement of volume fraction, surface area in two phase and single-phase materials.

Experiment 2: To study the Recovery, Recrystallization and Grain growth behavior of given material.

Experiment 3: To study the phase transformation of Pb-Sn eutectic alloy using DSC.

Experiment 4: Draw the cooling curves of Pb-Sn alloy with the help of DTA.

Experiment 5: To study the precipitation Hardening behavior mechanism in Al-alloys.

Experiment 6: Nucleation of Ice from Water: A Modelling Approach.

Experiment 7: Study of nucleation and growth in Eutectoid steel.

Experiment 8: To study the surface hardening treatments like carburizing/Boronizing on steels.

Suggested textbooks :

Solid State Phase Transformations, V. Raghavan, Prentice Hall India Learning Private Limited, 1987.

Phase Transformations in Metals and Alloys, David A. Porter and Kenneth E. Easterling, Third Edition, CRC Press, 2017.

Suggested reference books :

Physical Metallurgy Principles, Reza Abbaschian, Lara Abbaschian, and Robert E. Reed-Hill, Cengage, 2013.

Mechanisms of Diffusional Phase Transformations in Metals and Alloys, Hubert I. Aaronson, Masato Enomoto, and Jong K. Lee, CRC Press, 2016.

Subject Name: Materials Characterization **Subject Code: BTCMTPCC502** **Subject Credit: 4**

Course objective:

- To obtain knowledge on various structural and microstructural characterization techniques of materials.
- To study the principles, theory and practice of various characterization techniques

Course outcomes:

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

- Determine crystal structures of materials.
- Analyse microstructure of materials at different length scales
- Analyse defects and fracture surfaces of the tested materials
- Indicate instrumentation associated with and operating principles of various techniques.

Course Content:

Module 1: Structural Characterization: X ray diffraction Symmetry, Lattice, points groups, Bravais lattices, crystal systems, X-ray generation, Bragg Law, factors influencing intensity, Techniques, Indexing, precise lattice parameter determination, residual stress measurement **(10 hours)**

Module 2: Microstructural Characterization: Optical Microscopy: Introduction, Contrast, Magnification, Resolution, Numerical aperture, Coherent and incoherent waves, Rayleigh and Abbe's criterion for resolution, Different lens defects, Depth of field, Depth of focus, Bright field microscopy, Dark field microscopy, Phase contrast microscopy, Sample preparation for metallography **(10 hours)**

Module 3: Scanning electron microscopy: Electron Specimen interaction, Magnification, Resolution, Depth of field, Construction and principles, Contrast, sample preparation, Different detectors, contrast and image quality **(10 hours)**

Module 4: Transmission Electron Microscopy: Construction and principles, sample preparation, Different modes, lens defects and it correction, principles of Diffraction, Ewald spheres, Indexing, Kikuchi lines, Imaging, application on materials Chemical Characterization: Basic principles of spectroscopic techniques: EDS, WDS, XPS, EELS **(10 hours)**

Characterization Laboratory

Course Objectives:

To obtain knowledge on basic microstructural analysis of materials and to study microstructural stability.

Course Outcomes:

By completing this laboratory, the student will be able to:

- Prepare specimens for metallographic analysis
- Perform microstructural analysis using SEM and TEM
- Characterize defects and fracture surfaces in materials
- Carry out thermal analysis to study phase stability

Course Contents:

(XRD/Electron Microscopy/Thermal Analysis)

Module 1: Specimen preparation for scanning electron microscopy, transmission electron microscopy **(8 hours)**

Module 2: Scanning electron microscopy, Transmission electron microscopy, interpretation of micrographs, SAD analysis **(10 hours)**

Module 3: X-ray diffraction techniques, phase analysis, indexing of powder patterns **(10 hours)**

Module 4: TGA, DTA **(2 hours)**

Suggested reading:

1. Fundamentals of Light Microscopy and Electronic Imaging: Douglas B. Murphy and Michael Davidson, Wiley-Blackwell, 2012

2. Scanning Electron Microscopy and X-Ray Microanalysis: A Text for Biologists, Materials Scientists, and Geologists by Joseph Goldstein and Dale E. Newbury, Springer 2011

3.Elements of X-ray diffraction: B.D. Cullity, Pearson Education 2014

4. Electron microscopy and analysis: P. J. Goodhew, J. Humphreys, R. Beanland, 3rd edition, CRC Press 2000

Subject Name: Foundry Process & Technology **Subject Code: BTCMTPCC503** **Subject Credit: 4**

Course objective:

To impart the fundamentals of Foundry Process & Technology and understanding of various foundry processes, solidification of metal and quality control parameters.

Course outcome:

At the end of the course, the students would understand the fundamental Foundry Process & Technology, different Foundry processes, microstructure and testing for casting Product.

MODULE 1: Introduction: Introduction to metal casting and foundry industry in modern industrial scenario. Advantages and limitations of casting methods. Classification of foundries. Different sections in a foundry and their functions. Important cast metals and alloys-their composition, properties and uses **(3 hours)**

MODULE 2: Patterns Making: Types of patterns, brief classification of pattern making materials, consideration in selection of pattern materials, color coding, pattern allowances, core boxes, types of core boxes **(8 hours)**

MODULE 3: Moulding Processes: Types of sand and their properties, advantages and limitations, Molding sand and its properties. Selection of Foundry Clay (Bentonite Structure, Base exchange capacity & Acceptability Test,). Additives, Mechanization of Sand molding Process, Classification of molding processes and casting processes, brief description of all processes such as green sand dry sand, loam sand floor, pit and machine molding. Gating System, Element of gating systems, types of gates, Riser System, use, placement, riser design considerations, Caine's method & Kvoronov's rule **(10 hours)**

MODULE 4: Casting Processes: Special Molding Processes, Carbon dioxide molding process, Investment casting process, Die casting process, Shell molding process, Full molding process, Vacuum-Sealed casting process, Centrifugal casting processes etc **(5 hours)**

MODULE 5: Melting Practice: Melting of cast iron, Mechanical features of cupola, operational steps and principles of cupola operation, Advanced practices in the cupola operation, melting of aluminum and copper-based alloys including mold treatments such as dressing, grain refining, and modification **(7 hours)**

MODULE 6: Solidification of Casting: Solidification of Metals, Alloys & Eutectics, (Nucleation & Growth Process, Critical nucleus size, Supercooling, G/R ratio, Cell, Dendritic & Random dendritic structure, Segregation & Coring, Eutectics, Compositions in Cast Irons, FG & SG structures, Metallic Glass). Mold dilation, Mold-metal reactions. Structure & Section sensitivity **(8 hours)**

MODULE 7: Quality Control in Foundry: Casting defects, their causes & remedies. Shop-floor quality control tests e.g. composition control, Wedge test, fluidity, temperature measurement. Casting Modification by different methods like Friction stir processing. NDT testing & inspection **(4 hours)**

FOUNDRY METALLURGY LABORATORY

Sand Testing: Grading of Sand for foundry purpose, Determination of Optimum moisture content in Green Sand Practice, Determination of DCS of Core Sand, Determination of Permeability for molding sand mixtures, Sand Molding Practice for production of molds (Cope & Drag Pattern), Core- making Practice, Study of different types of Patterns. Gating Design Calculations, Riser Design by Modulus method, melting of metals & Production of Castings using sand molds/metal molds. Identification of Casting Defects & Cast-metal Structures. **(30 hours)**

Suggested Books:

1. Foundry Technology by P R Beeley (2001)
2. Manufacturing Technology: Foundry, Forming and Welding by P N Rao
3. Principles of Metal Casting by Heine
4. Foundry Engineering by Srinivasan
5. Principles of Foundry Technology by P Jain
6. Foundry Technology by O P Khanna
7. Foundry Technology by K P Sinha & D B Goel
8. Foundry Engineering by Howard Francis Taylor

Subject Name: Ironmaking Technology **Subject Code: BTCMTPCC504** **Subject Credit: 3**

Course objective:

The objective of this course work is to provide fundamental principles and a knowledge of important and various process routes of iron making.

Course outcome:

At the end of the course the students will be able to learn the principles and practice of various iron making processes, industrial practices, etc.

MODULE 1: Introduction: History of Iron (Steel), Different types of iron like meteoric Iron, wrought iron and cast iron, Iron and Steel Heritage of India, Materials flow of an integrated steel plant, Evolution of iron making technology, Raw materials scenario of iron making in India. **(2 hours)**

MODULE 2: Agglomeration Process of Iron Ore: Various raw materials used for production of sinter. Preparation of fuel mix & flux and their effect on the process of sintering. Calculation of charge components for producing desired quality of sinter to be used in iron blast furnace. Beneficiation process of the raw materials, raw material preparation, characteristics of raw materials for palletization, additives, binders etc. Green-ball formation, effect of process parameters on size and strength of green-pellets, testing of green-balls. Drying and firing of green balls, testing of indurate pellets like tumbler-test, reducibility, swelling index, reduction degradation index, Compressive strength etc. Briquetting & nodulizing process **(12 hours)**

MODULE 3: Coke Making: Fundamental, Important, Charging practices, Flow diagram of Coke Oven By-product plant, Properties of coke, Physical and chemical properties of coal and coke like CRI, CSR, proximate analysis, ultimate analysis, Free swelling index and other properties. **(3 hours)**

MODULE 4: Blast Furnace Iron Making: Introduction, Blast Furnace reactions and processes: an overview, General constructional features of a Blast Furnace, Performance of Blast Furnace, Charging system of solid materials from the Top, Blast Furnace refractory lining, Blast Furnace plant and accessories, Different systems of Blast furnace iron making process, Basic concepts of thermodynamics and kinetics of Iron Making, Physical chemistry of Blast Furnace reactions, Thermal and chemical features of the Blast Furnace, Internal zones and gas flow in Blast Furnaces, Factors affecting reducibility, Blast air and Blast furnace fuels, Blast Furnace productivity and the coke rate and fuel efficiency, Blast Furnace slag, Blast Furnace products handling & byproducts and their utilizations, Recycling of materials in the Blast Furnace, Control strategies for Sulphur, silicon, and other elements, Improvements in Blast Furnace technology (PCI, oxygen injection, high top pressure), Furnace irregularities and their remedies **(14 hours)**

MODULE 5: DRI Route of Iron Making: Limitations of blast furnace route, other options for iron production (DRI and Smelting route), Explain the terms of percent total iron, Percent metallic iron, Residual iron oxides, Total carbon, Impurities, Metallization, Degree of metallization, Equivalent metallization Percent reduction, Percent gangue and Quaternary basicity etc, Coal-based Sponge Iron Processes (Rotary Kiln Processes: SL / RN, Krupp-CODIR, DRC, ACCAR / OSIL. Retort Process: Kinglor Metor. Rotary Hearth process: Immetco, FASTMET), Gas-based Processes (Shaft Processes: MIDREX, HYL, Purofer, Fluidized Bed Processes: FIOR / FINMET, Iron Carbide, Circored) **(8 hours)**

MODULE-6: Smelting Reduction Route of Iron Making: Fundamentals of smelting reduction, Raw materials for smelting reduction, Romelt, ITMK3, HISARNA, Smelting Reduction (SR) technology – COREX, FINEX, HISMELT- basic principle, operation & effectiveness, Electro – Thermal Smelting Process -- basic principle, operation & effectiveness. **(6 hours)**

Suggested Books:

1. A first course in iron and steel making, Dipak Mazumdar, Orient Blacks wan Pvt. Ltd., (2015)
2. Ironmaking and steelmaking: Theory and Practice, Ahindra Ghosh & Amit Chatterjee, Phi Learning Pvt. Ltd. (2001)
3. The Iron Blast Furnace, Theory and Practice, J. G. Peacey & W. G. Davenport (1979)

4. Extractive Metallurgy 1: Basic Thermodynamics and Kinetics, Alain Vignes (ISTE Ltd.)
5. Extractive Metallurgy 2: Metallurgical Reaction Processes, Alain Vignes (ISTE Ltd.)
6. Extractive Metallurgy 3: Processing Operations and Routes, Alain Vignes (ISTE Ltd.)
7. Principles of blast furnace ironmaking: Theory and practice, A K Biswas (2000)
8. An introduction to Modern Iron Making, R. H. Tupkary, Khanna Publishers (2004)

Subject Name: Materials Processing **Subject Code: BTCMTPEC501** **Subject Credit: 3**

Course Objectives:

To impart basic knowledge on the manufacturing techniques of various materials.

Course Outcomes:

Students will be familiar with various manufacturing techniques to obtain simple/complex shapes.

Module I: Polymer processing: Rheology of polymeric materials, Compounding of plastics, processing techniques: Compression, Transfer, injection, blow molding, Extrusion, Calendaring, Thermoforming, Rotational molding, Compounding and processing of rubber (both latex and dry rubber) with different formulations: Casting, rubber extrusion, Dip coating (gloves, balloons etc.), fibre spinning and manufacturing processes. **(13 hours)**

Module II: Ceramic processing: Processing of traditional ceramics- spray granulation, Pressing, CIP, HIP, Slurry processing, Slip casting, Pressure casting, Tape casting, Gel casting, Injection molding, Extrusion; Rapid prototyping through Additive manufacturing, Electrophoretic deposition, Production of ceramic fibres, Electro-spinning; Drying, Binder burnout, Green machining, Sintering; Sol-gel processing, Thermal and plasma spraying, Thick and thin film coatings- PVD and CVD techniques; Vapor infiltration techniques **(13 hours)**

Module III: Metallic processing: Casting process- major casting techniques, Solidification and volume shrinkage, Casting design and defects, Fundamentals of deformation processing, Deformation work, Hot and cold working, Few forming processes and defects; Metal joining process- Concepts of Fusion and solid state welding processes, Brazing and soldering, Welding defects **(13 hours)**

Module IV: Glass processing: Raw materials for glass, Glass melting, refining, Glass batch preparation, Different process, Glass Tank Furnaces and refractories **(6 hours)**

Suggested Books:

1. P. Boch, J-C. Nièpce, Ceramic Materials: Processes, Properties, and Applications, Wiley-ISTE, 2007.

2. J-H. He, Electrospun Nanofibres and Their Applications, Smithers Rapra Technology, 2008.

3. Z. Tadmor, C.G. Gogos, Principles of Polymer Processing, 2nd ed., Wiley International, 2006.

4. T.A.Osswald, Polymer Processing Fundamentals, Hanser Publications, 1998.

5. M.N. Rahaman, Ceramic Processing and Sintering, 2nd ed.,,CRC press

6. F.C. Campbell, Elements of Metallurgy and Engineering Alloys, ASM International, 2008.

7. J. Beddoes, M.J. Bibby, Principles of Metal Manufacturing Processes, Elsevier, 2003.

8. G.E. Dieter, Mechanical Metallurgy, McGraw-Hill, 3rd ed., 1986.

9. E. Degarmo, J.T. Black and R.A. Kohser, Materials and Processes in Manufacturing, 9th ed., Wiley, 2002.

10. S. Kalpakjian, S.R. Schmid, Manufacturing Engineering and Technology, 6th ed., Pearson, 2009

Subject Name: Metal Forming Processes **Subject Code: BTCMTPEC502** **Subject Credit: 3**

Course Objectives: This course will focus on understanding the science and technology of different forming processes. The course will further illustrate the capabilities and applications of metal forming processes.

Course Outcomes: This course will allow to gain an understanding and appreciation of the breadth and depth of metal forming processes as well as permit to recognize the strong interrelationships between material properties and deformation processes.

Module 1: Introduction, Theory of Plasticity: stress tensor, hydrostatic & deviator components of stress, flow octahedral shear stress and shear strains, invariants of stress strain, slip line field theory plastic deformations of crystals. **(10 hours)**

Module 2: Plastic Forming of Metals-Forging: Basics of plastic forming & forging, mechanics of metal working, temperature in metal working, strain rate effects, friction and lubrication, deformation zone geometry; Forging process: classification, equipment, calculation of forging loads, forging defects, residual stresses (**10 hours)**

Module 3: Plastic Forming of Metals-Rolling and Extrusion: Rolling and Extrusion, classification, rolling mills, rolling of bars & shapes, rolling forces, analysis of rolling, defects in rolling, theories of hot & cold rolling, torque power estimation. Extrusion: classification, equipment, deformation lubrication and defects, analysis, hydrostatic extrusion, tube extrusion. (**10 hours)**

Module 4: Plastic Forming of Metals- Drawing and Sheet metal forming: Drawing & Sheet Metal Forming, rod & wire drawing equipment, analysis, deep drawing, tube drawing, analysis, residual stresses, sheet metal forming, methods, shearing and blanking, bending, stretch forming, deep drawing, forming limit criteria, defects, press brake forming, explosive forming. (**10 hours)**

Module 5: Unconventional Forming Methods: Classification; Process Principle, Applications, Equipments, Process Analysis and Die Design of Explosive Forming; Electro-Magnetic Forming; Electro-Hydraulic Forming; Laser Beam Bending and Laser Assisted Forming, Micro Forming Processes: Classification; Process Principle and Applications of Conventional Micro Forming Processes and Unconventional Micro-Forming Processes. **(8 hours)**

Suggested books:

1. Manufacturing Science, Ghosh and Mallick, East-West Press Private Limited
2. George E Dieter, Mechanical Metallurgy, Tata McGraw Hill, 3rd Edition
3. Materials and Processes in Manufacturing, Degarmo, J. T. Black, PHI, Pvt Ltd.

Subject Name: Composite Materials **Subject Code: BTCMTPEC503** **Subject Credit: 3**

Course objective:

- To obtain knowledge on classification, processing, characterization and applications of composite materials.
- To obtain knowledge on mechanical properties and failure mechanisms of composites under loading conditions for engineering applications

Course outcomes: After completion of the course, the students will have:

- Knowledge on classification, processing, characterization and applications of various composite materials
- Ability to arrive at different deformation and failure mechanisms of composite materials under different loading conditions in engineering applications.

Course Contents:

Module 1: Introduction: Definition, history, classifications, advantages and applications. **(2 hours)**

Module 2: Reinforcements and reinforcements-matrix interface **(4 hours)**

Module 3: Composites with metallic matrices: processing, properties, applications and some commercial MMCs **(9 hours)**

Module 4: Ceramic matrix composites: processing, properties, applications and detailed review of selected CMCs **(8 hours)**

Module 5: Polymer matrix composites: processing, properties, applications and detailed review of selected PMCs **(9 hours)**

Module 6: Properties of composites: Static mechanical properties, fatigue, impact and creep properties, toughening mechanisms, fracture behaviour and damage tolerance **(4 hours)**

Module 7: Advanced composites: Nanocomposites, hybrid composites, sandwich composites, smart composites and self-healing composites **(4 hours)**

Suggested reading:

1. Composite Materials- Engineering and Science; F L Mathews and R D Rawlings
2. Composite Materials: Science and Engineering; Krishan K. Chawla, Springer, 2012

Subject Name: Novel and Sustainable Materials **Subject Code: BTCMTPEC504** **Subject Credit: 3**

Course Objectives:

Basics concepts of novel and sustainable materials.

Course Outcomes:

1. Students will get the knowledge and understanding of the new Novel and Sustainable materials used in different Engineering Applications.

2. Study of existing green buildings-Energy auditing; Green building approaches on field through case studies; Performance rating systems; Environmental impact studies of building projects.

Course Contents:

Module 1: Smart materials and structures: System intelligence-components and classification of smart structures, common smart materials and associated stimulus-response, Application areas of smart systems **(5 hours)**

Module 2: Ferroelectric materials: Piezoelectric materials- piezoelectric effect, Direct and converse, parameter definitions, Piezoceramics, Piezopolymers, Piezoelectric materials as sensors, Actuators, and bimorphs **(5 hours)**

Module 3: Shape Memory Materials: Shape Memory Alloys (SMAs), Shape memory effect, Martensitic transformation, One way and two-way SME, training of SMAs, binary and ternary alloy systems, Functional properties of SMAs. Basic ideas related to Shape Memory Ceramics and Shape Memory Polymers **(10 hours)**

Module 4: Smart polymers: Thermally responsive polymers, Electroactive polymers microgels, Synthesis, Properties and Applications, Protein-based smart polymers, pH-responsive and photo-responsive polymers, Self-assembly, Molecular imprinting using smart polymers, Approaches to molecular imprinting, Drug delivery using smart polymers **(5 hours)**

Module 5: Smart hydrogels: Synthesis, Fast responsive hydrogels, Molecular recognition, Smart hydrogels as actuators, Controlled drug release, Artificial muscles, Hydrogels in microfluidics **(5 hours)**

Module 6: Introduction to Sustainable Materials: Definition of Sustainability, Sustainability parameters- Materials, Design and Energy, Sustainable Materials-Natural, Recycle and Man-made, Sustainable Development Goals (SDGs), Resources and Reserves in Construction Materials, Greenhouse Effect and Global Warming, Carbon Footprint of Materials; Different sources and environmental implications of Sustainable Materials; Resources for Sustainable Building Materials **(10 hours)**

Suggested Reference Books:

1. D.J. Leo, Engineering Analysis of Smart Material Systems, Wiley 2007.

2. M. Addington, D.L. Schodek, Smart Materials and New Technologies in Architecture, Elsevier 2005.

3. K. Otsuka, C.M. Wayman (Eds.), Shape Memory Materials, Cambridge University Press,1998.

4. M. Schwartz, New Materials, Processes, and Methods Technology, CRC Press, 2006.

5. I. Galaev, B. Mattiasson (Eds.), Smart Polymers: Applications in Biotechnology and Biomedicine,2nd ed., CRC Press, 2008.

6. N. Yui, R. J. Mrsny, K. Park (Eds.), Reflexive Polymers and Hydrogels: Understanding and Designing Fast Responsive Polymeric Systems, CRC Press, 2004.

7. Julian Allwood, Jonathan Cullen, Sustainable Materials - with both eyes open, UIT Cambridge Ltd., 2012

8. Alisson Mendes Rodrigues, Gelmires de Araujo Neves, Romualdo Rodrigues Menezes (Eds.), New Environmentally-Friendly and Sustainable Materials Hardcover – Import, MDPI, 2022

Subject Name: Ceramic and Polymeric Materials **Subject Code: BTCMTPEC505** **Subject Credit: 3**

Course Objectives:

To impart basic knowledge on ceramics and polymers as an important grade of materials for engineering applications.

Course Outcomes:

Students will be familiar with different ceramic and polymeric materials used for different versatile engineering applications.

Course Contents:

Module I

Basic concepts - Molecular forces - chemical bonding - Molecular weight studies -molecular weight distribution-configuration-conformation-Tacticity-Transitions in polymers-viscoelasticity-types of macromolecules-classification of polymers.

Structure and property relationships: Crystalline nature of polymers, factors affecting crystallization, crystallization and melting, melting factors affecting. The glassy state and glass transition.

Mechanistic aspects: General characteristics of chain growth polymerization, initiators, generation of initiators, free radical, anionic and cationic polymerization, ring opening polymerization, General characteristics of step growth polymerization, mechanism of step growth polymerization, coordination polymerization. Kinetics of addition, condensation and coordination polymerization. Copolymerization mechanism, kinetics. **(12 hours)**

Module II

Polymerization techniques: Homogeneous polymerization techniques- Bulk, Solution, Heterogeneous polymerization techniques- Emulsion, Suspension, solid phase polymerisation.

Mechanical properties: Tensile, flexural, compressive, abrasion, endurance, fatigue, hardness, tear, resilience, impact, toughness.

Polymer degradation: Types of degradation: Thermal, mechanical, ultrasonic and photodegradation, oxidative and hydrolytic degradation, Biodegradable polymers

Industrial Polymers: Production, properties and applications of industrial polymers; PP, PE, PVC, PS, polyamide, polyacrylates, polyester (PET, PBT). General purpose rubbers: NR, SBR, NPR, EPDM etc. **(12 hours)]**

Module III

General: Concepts of materials science, Definition & scope of ceramics and ceramic materials, classification of ceramic materials – conventional and advanced, Areas of applications.

Refractories: Classification of Refractories, Modern trends and developments, Basic raw materials, Elementary idea of manufacturing process technology, Flow diagram of steps necessary for manufacture, basic properties and areas of application. **(8 hours)]**

Module IV

Whitewares: Classification and type of Whitewares, Elementary idea of manufacturing process technology including body preparation, basic properties and application areas.

Ceramic Coatings: Types of glazes and enamels, Elementary ideas on compositions, Process of enameling & glazing and their properties. **(7 hours)**

Module V

Glass: Definition of glass, Basic concepts of glass structure, Batch materials and minor ingredients and their functions, Elementary concept of glass manufacturing process, Different types of glasses. Application of glasses.

Cement & Concrete: Concept of hydraulic materials, Basic raw materials, Manufacturing process, Basic compositions of OPC. Compound formation, setting and hardening. Tests of cement and concrete. **(8 hours)**

Books: (For Polymers)

1. F. W. Billmeyer, Textbook of polymer science, 3rd ed., John Wiley & Sons, Asia, New Delhi, 1994.

2. G. Odian, Principles of Polymerization, 4th ed., Wiley-Interscience, 2004

3. R. J Young and P. A. Lovell, Introduction to Polymers, 2nd ed., 2004

References:

1. M. Rubinstein, R.H. Colby, Polymer Physics, Oxford University Press, 2003.

2. P. Gosh, Polymer Science and Technology, Mc-Graw Hill, 2002.

(For Ceramics)

1) Elements of Ceramics - F.H Norton

2) Fundamentals of Ceramics - Barsoum

3) Introduction to Ceramics - W.D Kingery

4) Smith - Materials Science

5) Industrial Ceramics - Singer & Singer.

Subject Name: Surface Engineering **Subject Code: BTCMTPEC506** **Subject Credit: 3**

Course objective:

a) To develop understanding of various surface modification techniques to improve the surface properties and to evaluate their properties

b) To provide a comprehensive overview of the latest developments in thin films

c) To develop competence and skills to select the suitable thin film deposition techniques/surface modification methods for a certain application

Course outcome:

a) The students will have knowledge and understanding of necessity of thin films

b) The students will be aware of the role of surface engineering of materials to modify/improve the surface properties

c) The students will be able to select the suitable thin film deposition technique/surface modification method to achieve the required surface property.

Course Contents

Module I

Introduction to structure of solids: structure, morphology, energy, types, and classification **(2 hours)**

Surface dependent engineering properties: physical, chemical, and mechanical –their definition, origin and importance **(2 hours)**

Module II

Common surface-initiated engineering degradation/failures and their mechanism: wear, friction, fatigue, corrosion, oxidation **(4 hours)**

Importance of surface engineering (SE), Classification and scope of surface engineering of alloys and components, Methods, and principles of surface modification of materials; Strengthening mechanism of engineering materials –metallic and non-metallic **(4 hours)**

Module III

Conventional surface modification methods shot peening, flame and induction hardening, carburizing, nitriding, diffusion aided surface alloying **(8 hours)**

Surface coating techniques by chemical/electro-chemical routes: electro/electroless deposition, anodizing, galvanizing, etc. **(4 hours)**

Module IV

Advanced surface modification methods: laser, plasma, ion and electron beam assisted surface engineering **(6 hours)**

Module V

Film deposition techniques: Sputter Sputter deposition of thin films and coatings by RF, MF, DC, Magnetron, Pulsed laser, Ion beam, Ion implantation, electroplating, electroless plating, electro polishing, electroforming, chemical vapour deposition (CVD) and plasma enhanced CVD, atomic layer deposition, atomic layer chemical vapour deposition, molecular beam epitaxy, lithography, Langmuir Blodgett, Spin coating Inter diffusion, reactions and transformations in thin films: Fundamentals of diffusion, Inter-diffusionin thin metal films, Mass transport in thin films; Properties and characterisation of thin films- optical, electrical, mechanical and magnetic, structural morphology of deposited films and coatings Surface engineering of nanomaterials: Hybridization of nanomaterials, microencapsulation, synthesis, processing and characterization nano structured coatings and their application **(15 hours)**

Textbooks and References:

1. Surface Engineering for Wear Resistances (Introduction and classification of Wear), By: K.G. Budinski, Prentice Hall, Englewood Cliffs, 1988
2. Corrosion Engineering (classification of Corrosion), By: M.G. Fontana, M.C. GrawHill, N. York, 1987
3. Materials Science and Engineering by W. D. Callister
4. Introduction to Surface Engineering and Functionally Engineered Materials, by Peter Martin, WILEY, 2011
5.Surface Engineering of Metals: Principles, Equipment, Technologies, by: TadeuszBurakowski, TadeuszWierzchon, CRC Press, 1988
6.Surface Engineering for Corrosion and Wear Resistance, by JR Davis, ASM International, 2001
7. Modern Surface Technology, Edited by Friedrich-Wilhelm Bach, Andreas Laarmann, and Thomas Wenz, WILEY-VCH Verlag GmbH & Co. KGaA, Weinheim, Germany, 2006
8. M. H. Francombe, S. M. Rossnagel, A. Ulman, Frontiers of Thin Film Technology, Vol. 28, Academic press, 20

6th Semester

Subject Name: Steel Making Process **Subject Code: BTCMTPCC601** **Subject Credit: 3**

Course objective:

- Gather concepts about the basic principles of steel making.
- Understand about different processes of steel making.
- Gather knowledge about process of Secondary steel making.
- State about process of Ingot preparation, defects, remedies etc.

Course outcome:

At the end of the course, the students would have understanding of the fundamental principles of steel making, different steel making processes, secondary steel making processes and continuous casting processes.

Course Contents :

MODULE 1: Principle of Steel Making: Basic theory & Principle, Chemistry of different refining reaction, Carbon reaction, Sulphur reaction, Manganese reaction, Silicon reaction, Phosphorous reaction, Nitrogen & Hydrogen reaction, Slag formation & nature of slag; role of basicity and other factors on solute removal **(8 hours)**

MODULE 2: Review of Older Steel Making Process: Acid & basic Bessemer processes – their limitations; reason for their obsolescence, Basic principle of Open-Hearth Process - Acid and Basic process, Reasons for decline of Open-Hearth Process **(3 hours)**

MODULE 3: Basic Oxygen Converter Process: Basic principle, Mass and Energy Balance, LD converter process, Refractory lining, Reactions in LD converter, Bath Agitation Process (BAP), Combined blowing, LDAC / OLP Process, KALDO Process, ROTOR Process, Q- BOP PROCESS, EOF Process **(8 hours)**

MODULE 4: Electric Arc Furnace Steel Making: Basic principle, Mass and Energy Balance, Electric arc furnace constructional features & its accessories, Charge materials, refining, double slag practice, Development in EAF Technology, Name of different processes, Ultrahigh power (UHP) transformer, Furnace shell design, Design of cooling system for side wall and roof, New design of electrode, DC electric arc furnace, Oxy-fuel Burners and Oxygen Lancing, Foamy slag practice, Preheating of slag and waste heat recovery, Use of sponge iron as charge material, material Use of hot metal and iron carbide as charge **(10 hours)**

MODULE 5: Secondary Steel Making: Objectives of secondary steel making, Various processes, Vacuum ladle degassing, Recirculation Degassing (RH and DH), Recirculation Degassing with oxygen top lance (RH-OB), Ladle Degassing (VD, Tank Degassing), Vacuum Oxygen Decarburization (VOD), Ladle Furnace (LF), Ladle desulfurization by injection of active agents , Powder injection , Cored wire injection, Ladle-to-mold degassing, Deoxidation of steel, Deoxidation by metallic deoxidizers - Killed steels , Semi-killed steels , Rimmed steels, Deoxidation by vacuum, Diffusion deoxidation, Desulfurization of steel, Electroslag Remelting (ESR), Argon - oxygen decarburization (AOD) **(10 hours)**

MODULE 6: Ingot Casting Practice: Tapping & teeming of killed, semi-killed & rimming steels, Types of Ingots & Ingot models, Ingot defects — their causes & remedies. Continuous casting of steel, Types of continuous casting machine & diagram, Tundish, Common defects in continuous cast products and remedies **(4 hours)**

MODULE 7: Modern Trends in Steel Making and Green Steel Making: Modern and upcoming developments, Energy issues, Environment friendly steel making **(2 hours)**

Suggested Books:

1. Modern Steel making by R.H.Tupkary and V.R.Tupkary
2. Ironmaking and Steelmaking: Theory and Practice. by Ahindra Ghosh
3. Steel Making by A K Chakrabarti
4. Basic Concepts of Iron and Steel Making by Sujay Kumar Dutta, Yakshil B. Chokshi
5. A first course in iron and steel making by Dipak Mazumdar
6. Ironmaking and Steelmaking by Claire Davis
7. Iron and Steel by William F Hosford
8. Fundamentals of steelmaking by E. T. Turkdogan

Subject Name: Environmental Degradation of Materials Subject Code: BTCMTPCC602 Subject Credit: 4

Objectives of the course:

To familiarize the student with the extent and importance of material degradation. To study various aspects of corrosion and its control.

Course Outcomes:

After completing this course, the student should be able to:

- Explain the importance of studying corrosion
- Describe the thermodynamic aspects of corrosion
- Describe the kinetic aspects of corrosion
- Indicate the various forms of corrosion
- Explain the measurement and control of corrosion

Course Contents:

Module 1: Introduction, Definition, Forms of environmental degradation, Classification of corrosion Importance of corrosion studies and cost of corrosion; factor affecting corrosion **(4 hours)**

Module 2: Corrosion principles: Electrochemical aspects, Thermodynamic aspects of corrosion - Gibbs energy and electrochemical potential **(4 hours)**

Module 3: Metal-Electrolyte Interface, EMF series, Nernst relationship and Pourbaix Diagram **(6 hours)**

Module 4: Kinetic aspects of corrosion: Corrosion rate, Current density, Exchange current density, Mixed potential theory, Polarization and Passivation **(6 hours)**

Module 5: Forms of corrosion: Uniform Corrosion, Localized Corrosion; Pitting; Crevice Corrosion, Galvanic Corrosion and Protection; Concentration Cells, Intergranular Corrosion; De-alloying; Environmentally assisted failures (SCC), Hydrogen embrittlement; corrosion fatigue), Erosion; Fretting. Experimental methods to identify corrosion susceptibility **(10 hours)**

Module 6: Corrosion Measurements and Corrosion Control: Exposure studies, Electrochemical work bench, DC and AC methods of testing, Polarization measurements-Corrosion rate assessment by Tafel's extrapolation method, Linear polarization resistance (LPR). Coatings, Inhibitors, Cathodic and Anodic protection **(8 hours)**

Module 7: Degradation of polymeric, composite and ceramic materials and its prevention **(2 hours)**

Degradation of Materials Laboratory

1. To study electrochemical principles and types of corrosion.
2. To study & observe pitting corrosion in stainless steel.
3. To determine corrosion rate of given sample by weight loss method.
4. To determine corrosion rate of given sample by Tafel extrapolation method.
5. To study different types of corrosion protection methods.
6. To study Electroplating process and perform the electroplating of copper on a given base metal.
7. To study and perform the Anodizing of Aluminum in H_2SO_4 Solution.
8. To study different hot dipping process

9. To measure the wear rate of given specimen.

10. To Study Ion beam implantation for surface modification.

11. Problems based on Faraday's laws, Nernst's Equation and weight loss in corrosion.

12. Group discussion and Presentations on Recent trend in surface engineering.

13. Any other problem decided by faculty based on syllabus.

Major Equipment: Ultrasonic cleaner, oven, single pan balance, potentiostat, electrolytic tank, anodizing tank, wear test unit etc**.**

Suggested books:

Corrosion Engineering, Mar. G. Fontana, McGraw Hill Education, 2017

Electrochemical Techniques in Corrosion Science & Engineering. R.G. Kelly, J.R. Scully, D.W. Shoesmith, R.G. Buchheit, CRC Press., 2002

Suggested reference books:

Corrosion: Metal / Environment Reactions, Volume 1, L.L. Shreir, R.A. Jarman, G.T. Burstein, Butterworth-Heinemann, 1994.

Principles and Prevention of Corrosion, Denny A. Jones, Pearson, 1995.

Subject Name: Joining of Materials **Subject Code: BTCMTPCC603** **Subject Credit: 4**

Course objective: To impart the fundamental welding and understanding of various welding processes with quality measurement of welding joint.

Course outcome: At the end of the course, the students would understand the fundamental welding, different welding processes, microstructure and testing for welding joints.

Course Contents:

MODULE 1: Introduction: Different process of metal joining methods, Introduction and definition of welding, Arc and Gas Welding Equipment's tools and accessories, Fundamental of bonding, Welding arc and arc physics, Power sources for arc welding, Arc welding, Processes, Electrode, Function of Flux, Types of flux, Heat input, Heat intensity, effective shielding, different polarity etc Types of welding joints **(12 hours)**

MODULE 2: Welding Processes: Welding processes and types of Gas Metal Arc Welding, MIG Welding, TIG Welding, High power density welding processes (EB, LBW, PAW), Resistance welding processes, Solid-state Welding-Friction-stir welding, Submerged-arc welding, Thermit Welding, Electro-slag Welding, Explosives welding etc. **(18 hours)**

MODULE 3: Welding Metallurgy: Welding Metallurgy and weldability of Ferrous and Nonferrous Metals & alloys, Brazing, Soldering and Adhesive bonding, Brazability and Solderability of metals and alloys. importance of preheating, post heating, maintenance of inter pass temperature **(10 hours)**

MODULE 4: Welding Defects and Testing: Defects in welded, brazed and soldered joints and their significance, Destructive and Non-destructive testing of welded joints, Weldability test **(5 hours)**

Welding Laboratory (30 hours)

Welding Symbols, Hand practice on MMAW and GMAW processes. Demonstration on Processes: RSW, FSW, DB. Codes and specification of electrodes/filler wires for MMAW, GMAW, GTAW & SAW. To study bead profile, percentage dilution and width of heat affected zone (HAZ) under different arc welding parameters (Heat input). To study microstructure of welding metal and HAZ of steel and aluminum alloys performed under different arc welding parameters (Heat input). To characterize weld defects by DT, Radiography and UT. To study microhardness testing across weld metal and HAZ of welded steel and aluminum. To develop Weld Procedure Specification (WPS) for different materials

Suggested Books:

1. Welding Fundamentals by William A Bowditch
2. Welding Metallurgy and Weldability by John C Lippold
3. Introduction to Physical Metallurgy of Welding by K Easterling
4. Welding and Welding Technology by Richard Little
5. Modern Welding Technology by Howard B Cary and Scott Helzer
6. Welding Technology by Gower A Kennedy
7. Welding Technology by N K Srinivasan
8. Textbook of Welding Technology by O P Khanna
9. Advances in Welding Science and Technology by S A David
10. The book of Foundation of Welding Technology by K S Ghosh

Subject Name: Heat Treatment Technology **Subject Code: BTCMTPCC604** **Subject Credit: 4**

Course Objectives:

To have a broad overview of the principles and practice of heat treatment of various types of ferrous and non-ferrous metals and alloys

Course Outcomes:

At the end of the course, the student should be able to understand and analyze various methods of heat treatment to suggest a technique suitable for a particular alloy to achieve a set of desired properties.

Course Contents:

Module 1: What is steel, different types of steel, grades and specifications, carbon and alloy steels, major properties of steel we look for, cast iron and its various classifications. How steel is made – a brief outline, quality of steel, secondary refining of steel, concept of clean steel **(8 hours)**

Module 2: Fe-Fe_3C phase diagram, evolution of microstructures in steel during cooling, CCT and TTT diagrams, various phases, structure-property correlations, effects of alloying elements on steel properties, work hardening, standard tests **(8 hours)**

Module 3: Heat treatment of steel (bulk) – different techniques (annealing, normalizing, hardening, spheroidizing, tempering, etc.), applications, variation in properties, process control, defects **(7 hours)**

Module 4: Heat treatment of cast irons **(4 hours)**

Module 5: Special heat treatment techniques (martempering, austempering, maraging, etc.) **(6 hours)**

Module 6: Surface heat treatment of steel (carburizing, nitriding, carbonitriding, etc., induction, plasma, electron beam, laser, chemical methods), surface modifications (irradiation & other chemical methods) **(6 hours)**

Module 7: Heat treatment of non-ferrous metals **(6 hours)**

Heat Treatment Laboratory

Microstructure analysis of various heat-treated steels (annealed, normalized, quenched, tempered), Hardness profile of quenched steel, Microstructure and hardness profile of carburized steel **(30 hours)**

Suggested Books

- Heat Treatment: Principles and Techniques, T V Rajan, C P Sharma, Ashok Sharma, PHI, 2010
- Introduction to Physical Metallurgy, Sydney Avner, McGraw Hill, 2017
- Metals Handbook, ASM International, 1998
- Materials Science and Engineering, W D Callister, Wiley, 2014

Subject Name: Powder Metallurgy **Subject Code: BTCMTPEC601** **Subject Credit: 4**

Course Objective: To study fundamentals of powder metallurgy including powder processing techniques, powder characterizations and applications of powder metallurgy.

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

- Understand the fundamental aspects of powder metallurgy.
- Learn powder processing and characterization techniques.
- Gain knowledge on compaction, sintering and relevant theories.

- Gain knowledge about applications of powder metallurgy.

Course Contents:

Module 1: Introduction; Importance of powder metallurgy **(4 hours)**

Module 2: Powder Processing techniques (Chemical Methods, Electrolytic Methods, Atomization, Mechanical Methods) **(8 hours)**

Module 3: Powder characterization and testing: Particle size analysis, chemical composition and structure, microscopic analysis, permeability, adsorption methods and resistivity methods, particle shape, classifications, microstructure, specific surface area, apparent density, green density, porosity, shrinkage **(16 hours)**

Module 4: Powder compaction and sintering **(8 hours)**

Module 5: Applications **(4 hours)**

Powder Metallurgy Laboratory

Course Objectives:

To study various characteristics of metallic and non-metallic powders and evaluate the green density as well as strength characteristics (hardness) of cold-compacted and sintered (conventional) compact.

Course Outcomes:

After completing this course, the student will be:

- able to determine powder characteristics
- able to have knowledge on various powder testing equipment

Course Contents

Module 1: Powder Size and Characteristic **(10 hours)**

Module 2: Determination of powder density (apparent density and green density), porosity **(10 hours)**

Module 3: Determination of green strength **(10 hours)**

Suggested reading:

2. Powder Metallurgy: Science, Technology and Materials by A Upadhyaya, G S Upadhyaya

3. Powder Metallurgy: Science, Technology and Application by P C Angelo and R. Subramanian, Prentice Hall, 2008

Subject Name: Computational Materials Engineering **Subject Code: BTCMTPEC602** **Subject Credit: 4**

Course Objectives: To introduce the general concepts and methods for computational data analysis and to develop skill and tools for analyzing.

Course Outcomes: This course will allow students to understand the capabilities provided by various data as well as to analyze different methods and apply the appropriate ones to solve real problems.

Course Contents

Module 1: Need of Computational Materials Engineering: Examples of challenges in design of materials for challenging applications, bottleneck areas of materials technology, introduction to the Integrated Computational Materials Engineering (ICME) approach **(5 hours)**

Module 2: Atomistic schemes in Computational Materials Engineering: Introduction to basics of statistical mechanics, basics of molecular dynamics simulation, application of molecular dynamics for property prediction, basics of Monte Carlo approach and its application for modelling materials properties **(10 hours)**

Module 3: Prediction of thermodynamic properties of materials: Application of CALPHAD type approaches for prediction of phase diagrams and introduction to recent algorithms using atomistic simulations **(6 hours)**

Module 4: Mesoscale methods in materials science: Quantification of microstructure: Application of Monte Carlo and Cellular Automata method for generation of microstructure, Introduction to Phase Field Method and Finite Element Method **(7 hours)**

Module 5: Basics of Multiscale Modelling involving development of method for improved structure-property correlation: Basics of bridging schemes in multiscale models **(5 hours)**

Module 6: Machine learning in Materials Science and Engineering, Basics of Machine learning: Supervised learning, Unsupervised learning and Reinforced learning, Deep Learning: Introduction to Artificial Neural Network, Mathematical background of ANN and Building of ANN Introduction to Convolution Neural Network: Mathematical background of CNN and Building of CNN Introduction to genetic algorithm: Optimization techniques using bi and tri clustering **(12 hours)**

Computational Materials Engineering Laboratory (30 hours)

Module 1: Introduction to Integrated Computational Materials Engineering for structure-property correlation.

Module 2: Introduction to Atomistic Simulation Environment and basics of Python programming.

Module 3: Application of statistical mechanics-based tools for determination of thermodynamic properties such as specific heat capacity, enthalpy and free energy.

Module 4: Molecular dynamics of elemental metals and binary alloys to study the phase stability.

Module 5: Monte Carlo based microstructure generation-studying grain growth phenomena.

Module 6: Cellular Automata based microstructure design studies.

Module 7: Using COMSOL to simulate any one of the multi-physics phenomena (Induction heating of steel slab, Cooling or solidification of steel, continuous casting, multiscale 3D packed reactor, localised corrosion, anodization of Al). Use of ProCAST for casting simulation.

Module 8: Using ANSYS to simulate steelmaking processes: Creation of geometry, computational mesh generation, formulation of models, turbulence models, etc.

Module 9: Application of ANSYS to simulate metal forming processes**.**

Module 10: Application for machine learning based approaches for microstructure identification (e.g., Deep Learning approaches in image analysis).

Suggested Books:

1. Computational Materials Engineering: An Introduction to Microstructure Evolution, KGF Janssens, D. Raabe, E. Kozeschnik, M. Miodownik, B. Nestler, Academic Press.

2. Statistical mechanics: A survival guide, A. M. Glazer and J. S. Wark, Oxford University Press.

3. Integrated Computational Materials Engineering (ICME) for Metals: Using multiscale modelling to invigorate engineering design with science, M.E. Horstemeyer, Wiley.

4. Machine Learning, Anuradha Srinivasaraghavan, Vincy Joseph, Wiley.

5. Computational Materials Engineering: An Introduction to Microstructure Evolution, Authors: Ernest Kozeschnik, Mark A Miodownik, Britta Nestler, Dierk Raabe, Koenraad G. F. Janssens.

6. Artificial Neural Networks -B. Yegnanarayana, Prentice-Hall of India, 1999

7. Materials Informatics: Methods, Tools, and Applications, Olexandr Isayev (Editor), Alexander Tropsha (Editor), Stefano Curtarolo (Editor), ISBN: 978-3-527-34121-4, Wiley

Subject Name: Industrial Pollution and Environmental Control **Subject Code: BTCMTOEC601** **Subject Credit: 3**

Course Objectives:

- To develop interest and awareness about the environment we live in
- To obtain knowledge about the possible causes and sources of environmental pollution
- To obtain knowledge about the remedies and methods of abatement of industrial pollution
- To get an overview of the associated rules and regulations

Course Outcomes:

- To develop interest among students regarding environment and its protection
- To provide basic understanding of environmental engineering to meet the expectation of Industries for pollution control in their premises to comply with newer and tougher laws and acts that are being enforced in India and globally
- To introduce the principles and methods to control air, water & soil pollution

- To develop basic understanding of the following topics : (1) sources of water, air and land pollution (2) recycle and reuse of waste, energy recovery and waste utilization (3) various pollution types and measurement (4) design of pollution abatement systems for particulate matter and gaseous constituents (5) design of waste-water and industrial effluent treatment (6) hazardous waste treatment and disposal (7) solid-waste disposal and recovery of useful products (8) standards, Indian and global norms, laws and acts, targets

Course Contents:

- **Module 1**: (a) Environmental Problems, their causes, and sustainability (b) Causes of modern environmental concerns (overpopulation, tragedy of the commons, affluenza, poverty) (c) IPAT model for human impact on the environment (d) Ecological footprint analysis (e) Earth Overshoot Day (f) Sustainable development – need and importance, principles of sustainability, environmentally sustainable societies,2030 Agenda for sustainable development (g) Ecosystems: what are they and how do they work, matter & energy flow in ecosystems, Natural capital and ecosystem services (provisioning services, regulating services, cultural services) **(9 hours)**
- **Module 2** : (a) Role of biogeochemical cycles in globalization and sustainable development (b) Human population and urbanization: population explosion, urbanization and sustainability; Challenges of megacities; Spatial patterns of urbanization; Urban sprawl – causes, consequences and regulation; Smart growth, eco-cities and sustainable mobility (c) Understanding Air Pollution: Air pollutants – classification, sources & impacts, Clean air act and national ambient air quality standards (NAAQS); Air quality index; Ground level ozone and photochemical smog; Long-range transboundary air pollution; Ozone depletion in the Antarctic stratosphere and the Montreal Protocol **(9 hours)**
- **Module 3**: (a) Understanding and improving indoor air quality (b) Climate Change: Evidence, causes and effects, Keeling curve; Global warming potential; Role of IPCC in the understanding of climate change (c) Global climate agreements – the UN Framework. Convention on Climate Change, the Kyoto Protocol, and the Paris Agreement (d) Mitigation strategies – carbon capture, utilization and storage; adapting to climate change (e) Energy and Sustainability: Global energy trilemma; Energy efficiency and conservation; Renewable energy for human sustainability (solar, wind, hydroelectricity, biomass, geothermal energy) **(10 hours)**
- **Module 4** : (a) Waste Management: Consumerism & throw-away culture (b) Characteristics of municipal solid waste; Sustainable practices in waste management; CPHEEO guidelines for solid waste management (c) Transition to zero waste lifestyle; Tackling the rise of e-waste (d) Looming waste crisis from global renewable energy boom (e) Industrial Ecology and Circular Economy: Urban ecology and urban metabolism; material and energy flows of leading global economies; origin of industrial ecology, its definition and its relation to the concept of sustainability; closing material loops (open vs. closed-loop systems) and transition to a circular economy (f) Circular business models **(10 hours)**
- **Module 5** : (a) Tackling Water Pollution: Sources of water pollution; Classification of water pollutants (b) Overview of water pollution mitigation measures (c) Applicable wastewater discharge standards (new standard by the National Green Tribunal) and typical flow schemes for sewage treatment plant (d) Potable water quality requirements (IS 10500); Water quality index (e) Overview of water treatment plant (f) Noise Pollution: Sources and effects of noise; quantification of noise pollution; Control and regulation rules in India **(7 hours)**

Suggested Books:

- Industrial Pollution Control by Sanjay Gupta, Vayu Education of India, 2012
- Environmental Engineering by Surbhi Jain and Mukesh Raj, Books Clinic, 2020

- Environmental Pollution Control Engineering by C S Rao, New Age International Publishers, 2021

Subject Name: Production & Operation Management **Subject Code: BTCMTOEC602** **Subject Credit: 3**

Course Objectives:

To familiarize the students with the role of operations and its interaction with other activities of a firm/organization and their integration in a highly competitive global environment. To enable the students to apply the understanding of production processes in quantitative analysis of problems arising in the management of operations.

Course Outcomes:

The course will introduce students to the many operations topics and issues faced by leading organizations, both in service and in manufacturing. The goal of this course is to help students gain an understanding of what operations management involves, how it relates to other functional areas in an organization, the types of problems that are faced by operations managers, and common decision-making approaches The course will further allow the students to understand the role of operations management in achieving organizational competitiveness. to appreciate the concepts of lean production and maintenance management in operations and to comprehend the key decision areas of operations and analyze data for effective decision making in operations management

Course Contents

Module 1: Introduction: System concept of production; Product life cycle; Types and characteristics of production system; Productivity; Process and product focused organization structures; Management decisions – strategic, tactical and operational **(3 hours)**

Module 2: Forecasting: Patterns of a time series – trend, cyclical, seasonal and irregular; Forecasting techniques: moving average, simple exponential smoothing, linear regression; Forecasting a time series with trend and seasonal component **(5 hours)**

Module 3: Materials Management and Inventory Control: Components of materials management; Inventory control: EOQ model, Economic lot size model, Inventory model with planned shortages, Quantity discounts for EOQ model; ABC analysis; Just-in-time inventory management. **(5 hours)**

Module 4: Materials Requirement Planning: MRP concept – bill of materials (BOM), master production schedule; MRP calculations **(3 hours)**

Module 5: Machine Scheduling: Concept of Single machine scheduling – shortest processing time (SPT) rule to minimize mean flow time, Earliest due date (EDD) rule to minimize maximum lateness, Total tardiness minimizing model; Minimizing makespan with identical parallel machines; Johnson's rule for 2 and 3 machines scheduling **(4 hours)**

Module 6: Project Scheduling: Activity analysis; Network Techniques, Terms related to Network Planning Methods; Programme Evaluation Review Technique (P.E.R.T), Critical Path Method (C.P.M); Smoothing, Application of Network Techniques, Crashing of project network. **(5 hours)**

Module 7: Quality Assurance: Meaning of Quality; Quality assurance system; choice of process and quality; Inspection and control of quality; Maintenance function & quality; Process control charts: x-chart and R-chart, p-chart and c-chart; Acceptance sampling: Operating characteristic (O.C) curve, Single sampling plan, Double sampling plan, Acceptance sampling by variables; concept of Six Sigma **(5 hours)**

Module 8: Work Study: Definition and Concept, Need for Work Study, Advantages of Work Study, Objectives of Method Study, Objectives of Work Measurement, Method Study Procedure, Process Charts Symbols, Flow Process Charts, Flow Process Charts, Flow Diagram, String Diagram, Multiple Activity Chart, Analysis of Motion, Design of Work Place Layout, Therbligs, S.I.M.O Chart, Method-Time-Measurement (M-T-M), Work Factor, Work Sampling, Ergonomics **(10 hours)**

Module 9: Management Information Systems (MIS): Definition, Evolution of MIS, Need/Objective/Function of MIS, Difference between Data and Information, Distinction between a Data Processing System and a Management Information System, Need for Information, Management Information Categories, Designing Information Systems, Integrated Information Systems, Application of MIS, Future of MIS **(5 hours)**

Books:

1. Modern Production/Operations Management, 8th ed.by Buffa and Sarin, John Wiley & Sons.
2. Production and Operations Management by R. Panneerselvam, PHI.
3. Operations Management: Theory & Practice by Mahadevan, B, 3rd ed., Pearson Education.
4. Industrial Engineering and Management by O. P. Khanna, Dhanpat Rai Publications (P) Ltd.
5. Operations Management by Russell & Taylor, 4th ed.' PHI.
6. Production and Operations Management by Adam and Ebert, PHI.

Subject Name: Indian Constitution (Mandatory Course) **Subject Code: BTCMTMC601** **Subject Credit: Non-credit Course**

Constitution of India – Basic features and fundamental principles

The Constitution of India is the supreme law of India. Parliament of India cannot make any law which violates the Fundamental Rights enumerated under the Part III of the Constitution. The Parliament of India has been empowered to amend the Constitution under Article 368, however, it cannot use this power to change the "basic structure" of the constitution, which has been ruled and explained by the Supreme Court of India in its historical judgments. The Constitution of India reflects the idea of "Constitutionalism" – a modern and progressive concept historically developed by the thinkers of "liberalism" – an ideology which has been recognized as one of the most popular political ideology and result of historical struggles against arbitrary use of sovereign power by state. The historic revolutions in France, England, America and particularly European Renaissance and Reformation movement have resulted into progressive legal reforms in the form of "constitutionalism" in many countries. The Constitution of India was made by

borrowing models and principles from many countries including United Kingdom and America. The Constitution of India is not only a legal document but it also reflects social, political and economic perspectives of the Indian Society. It reflects India's legacy of "diversity". It has been said that Indian constitution reflects ideals of its freedom movement, however, few critics have argued that it does not truly incorporate our own ancient legal heritage and cultural values. No law can be "static" and therefore the Constitution of India has also been amended more than one hundred times. These amendments reflect political, social and economic developments since the year 1950.The Indian judiciary and particularly the Supreme Court of India has played a historic role as the guardian of people. It has been protecting not only basic ideals of the Constitution but also strengthened the same through progressive interpretations of the text of the Constitution. The judicial activism of the Supreme Court of India and its historic contributions has been recognized throughout the world and it gradually made it "as one of the strongest court in the world".

Course Content:

1. Meaning of the constitution law and constitutionalism
2. Historical perspective of the Constitution of India
3. Salient features and characteristics of the Constitution of India
4. Scheme of the fundamental rights
5. The scheme of the Fundamental Duties and its legal status
6. The Directive Principles of State Policy – Its importance and implementation
7. Federal structure and distribution of legislative and financial powers between the Union and the States
8. Parliamentary Form of Government in India – The constitution powers and status of the President of India
9. Amendment of the Constitutional Powers and Procedure
10. The historical perspectives of the constitutional amendments in India
11. Emergency Provisions: National Emergency, President Rule, Financial Emergency
12. Local Self Government – Constitutional Scheme in India
13. Scheme of the Fundamental Right to Equality
14. Scheme of the Fundamental Right to certain Freedom under Article 19
15. Scope of the Right to Life and Personal Liberty under Article 21

7th Semester

Subject Name: Design and Selection of Materials **Subject Code: BTCMTPCC701** **Subject Credit: 3**

Course Objective:

To provide the students with basic knowledge of design parameters and materials selection for proper applications in different domains

Course Outcome:

Students will get to know the design basics used in engineering applications and would be able to choose the right materials for specific applications

Course Contents

Module I: Introduction to design, Design philosophy, Optimized design. Review of common engineering materials and their properties, Different types of materials – Metallic Ferrous, Non-Ferrous, Non- metallic, Composites, ceramic, Plastics, Polymers, etc. **(6 hours)**

Module II: Improvement of properties through heat treatment and alloying, Modes of failure, Review of stress calculation in various situations - axial, bending, torsion loads and combined effect, stress concentration, Factor of safety, Theories of failure and choice of failure theory of design, Manufacturing aspects of design – Manufacturing processes (casting, forming, machining, welding etc.) Fit and tolerance, surface roughness **(12 hours)**

Module III: Design of shaft – FOS, ASME Code /IS Code Design, strength and rigidity (Axial. Bending torsion & combined loading), Effect of keyway and splined, Stepped shaft, Endurance diagram and Design criteria, Design for fatigue life, Cumulative fatigue damage, Strain life equation. **(12 hours)**

Module IV: Design criteria for fracture and creep **(4 hours).**

Design for Stability - Buckling analysis **(2 hours).**

Design of pin-joints – Cotter / Knuckle & Universal joint **(4 hours).**

Screw joints / bolted joints, Transmission screws, Riveted joints, Welded joints **(5 hours)**

Books:

1. R. Rajput, A Text book of Machine Design, 25th ed., S Chand Publushers, 2019.

2. M. F Ashby, Materials Selection in Mechanical Design, 4th ed., Butterworth-Heinemann, 2011.

3. Shigley's, Mechanical Engineering Design, McGraw Hill Series in Mechanical Engg, 10th Edition

Subject Name: Alloy Steel **Subject Code: BTCMTPCC702** **Subject Credit: 3**

Course objective: To study the composition, properties, applications and heat-treatment processes for various alloy steels.

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

- Understand the importance of alloy steel.
- Acquire knowledge about composition, properties, applications, and heat-treatment processes for various alloy steels.

Course Content

Module 1: Introduction and background **(4 hours)**

Module 2: Role of alloying elements **(8 hours)**

Module 3: Low alloy steel **(8 hours)**

Module 4: Stainless steel **(8 hours)**

Module 5: Special alloy steels **(8 hours)**

Module 4: Thermo-mechanical treatment of steels **(4 hours)**

Suggested reading:

1. Alloy Steel: Properties and Use by Leroy Sydney

2. Heat Treatment: Principles and Techniques by T.V. Rajan, C.P. Sharma and Ashok Sharma.

Subject Name: Non-destructive Testing & Evaluation **Subject Code: BTCMTPCC703** **Subject Credit: 4**

Course Objectives

Introduce basic concepts of non-destructive testing Familiarize with characteristics of ultrasonic test, transducers, rejection and effectiveness. Describe concept of liquid Penetrant, eddy current and magnetic particle tests, its applications and limitations. Explain the principles of infrared and thermal testing, applications and honeycomb and sandwich structures case studies. Impart NDE and its applications in pressure vessels, casting and welded constructions.

Course Outcomes

At the end of the course, student will be able to: Explain various methods of non-destructive testing; Apply relevant non-destructive testing method different applications; Explain the applications of railways, nuclear and chemical industries; Outline the limitations and disadvantages of NDE; Explain the applications of NDE of pressure vessels, casting and welding constructions

Course Contents

Module 1: Overview of NDT

NDT Versus Mechanical testing, Overview of the Non-Destructive Testing Methods for the detection of manufacturing defects as well as material characterization. Relative merits and limitations, Various physical characteristics of materials and their applications in NDT., Visual inspection – Unaided and aided.

Introduction to non-destructive testing: Radiographic test, Sources of X and Gamma Rays and their interaction with Matter, Radiographic equipment, Radiographic Techniques, Safety Aspects of Industrial Radiography. **(7 hours)**

Module 2: Surface NDE Methods

Liquid Penetrant Testing - Principles, types and properties of liquid penetrants, developers, advantages and limitations of various methods, Testing Procedure, Interpretation of results. Magnetic Particle Testing- Theory of magnetism, inspection materials Magnetisation methods, Interpretation and evaluation of test indications, Principles and methods of demagnetization, Residual magnetism.

Liquid Penetrant Test: Liquid Penetrant Test, Basic Concepts, Liquid Penetrant System, Test Procedure, Effectiveness and Limitations of Liquid Penetrant Testing. Eddy Current Test: Principle of Eddy Current, Eddy Current Test System, Applications of Eddy Current-Testing Effectiveness of Eddy Current Testing. Magnetic Particle Test: Magnetic Materials, Magnetization of Materials, Demagnetization of Materials, Principle of Magnetic Particle Test, Magnetic Particle Test Equipment, Magnetic Particle Test Procedure, Standardization and Calibration, Interpretation and Evaluation, Effective Applications and Limitations of the Magnetic Particle Test. **(10 hours)**

Module 3: Thermography and Eddy Current Testing (ET)

Thermography- Principles, Contact and non-contact inspection methods, Techniques for applying liquid crystals, Advantages and limitation - infrared radiation and infrared detectors, Instrumentations and methods, applications. Eddy Current Testing-Generation of eddy currents, Properties of eddy currents, Eddy current sensing elements, Probes, Instrumentation, Types of arrangement, Applications, advantages, Limitations, Interpretation/Evaluation.

Infrared And Thermal Testing: Introduction and fundamentals to infrared and thermal testing–Heat transfer –Active and passive techniques –Lock in and pulse thermography–Contact and non-contact thermal inspection methods–Heat sensitive paints –Heat sensitive papers –-thermally quenched phosphors liquid crystals –techniques for applying liquid crystals –other temperature sensitive coatings –Inspection methods –Infrared radiation and infrared detectors–thermo mechanical behavior of materials–IR imaging in aerospace applications, electronic components, Honey comb and sandwich structures–Case studies. **(10 hours)**

Module 4: Ultrasonic Testing (UT) and Acoustic Emission (AE)

Ultrasonic Testing-Principle, Transducers, transmission and pulse-echo method, straight beam and angle beam, instrumentation, data representation, A/Scan, B-scan, C-scan. Phased Array Ultrasound, Time of Flight Diffraction. Acoustic Emission Technique – Principle, AE parameters, Applications

Ultrasonic test: Principle of Wave Propagation, Reflection, Refraction, Diffraction, Mode Conversion and Attenuation, Sound Field, Piezo-electric Effect, Ultrasonic Transducers and their Characteristics, Ultrasonic Equipment and Variables Affecting Ultrasonic Test, Ultrasonic Testing, Interpretations and Guidelines for Acceptance, Rejection -Effectiveness and Limitations of Ultrasonic Testing. **(10 hours)**

Module 5: Radiography (RT)

Principle, interaction of X-Ray with matter, imaging, film and film less techniques, types and use of filters and screens, geometric factors, Inverse square, law, characteristics of films - graininess, density, speed, contrast, characteristic curves, Penetrameters, Exposure charts, Radiographic equivalence. Fluoroscopy- Xero-Radiography, Computed Radiography, Computed Tomography

Industrial Applications of NDE: Span of NDE Activities Railways, Nuclear, Non-nuclear and Chemical Industries, Aircraft and Aerospace Industries, Automotive Industries, Offshore Gas and Petroleum Projects, Coal Mining Industry, NDE of pressure vessels, castings, welded constructions. **(8 hours)**

Non-Destructive Testing Laboratory

Non-destructively Evaluation using Liquid Penetrant Testing (LPT), Ultrasonic Testing (UT), Magnetic Particle Testing (MPT), Acoustic Emission (AE) Testing, Eddy Current Testing, Radiography (RT) **(30 hours)**

Textbooks

1. Baldev Raj, M. Thavasimuthu, T. Jayakumar, “Practical Non-Destructive Testing”, Woodhead Publishing House, 2002
2. J Prasad, GCK Nair, “Non-destructive test and evaluation of Materials”, Tata mcgraw-Hill Education Publishers, 2008.
3. Josef Krautkrämer, Herbert Krautkrämer, “Ultrasonic testing of materials”, 3rdedition, Springer-Verlag, 1983.
4. X. P. V. Maldague, “Non-destructive evaluation ofmaterials by infrared thermography”, 1stedition, Springer-Verlag, 1993.

Reference Books

1. Gary L. Workman,Patrick O. Moore,Doron Kishoni, “Non-destructive, Hand Book, Ultrasonic Testing”, 3rdedition, Amer Society for Nondestructive, 2007.
2. ASTM Standards, Vol 3.01, Metals and alloys

Subject Name: Failure Mechanism & Analysis Subject Code: BTCMTPEC701 Subject Credit: 3

Objectives of the course

- To highlight factors governing the failure of materials and types of failure
- To evaluate the mechanisms and environmental effects associated with failure.
- To identify various failures in heat treatments, and deformation processing, and methods to prevent them.

Course Outcomes

After completing this course, the student will be:

- able to identify the types of failures in engineering components under service.
- able to apply the knowledge of tools and techniques to perform failure analysis.

- able to perform fractographic analysis after various failures.
- able to identify different failure mechanisms resulting from manufacturing processes.

Course Contents

Module 1: Aims of failure analysis. Important factors causing the premature failure of metallic components and structures. Tools and techniques in failure analysis. **(10 hours)**

Module 2: Fractography. Types of failures; ductile, brittle, fatigue, creep, corrosion, wear. **(10 hours)**

Module 3: Failure mechanisms. Embrittlement phenomena. Environmental effects. **(10 hours)**

Module 4: Failures due to faulty heat treatments. Failures in metal forming and welding. Case studies in failure analysis. Prevention of failures. **(10 hours)**

Suggested Books

1. Failure Analysis of Engineering Materials, Charles Brooks, Ashok Choudhury, Charlie R. Brooks, McGraw-Hill Education; 2001

2. Failure Analysis: Fundamentals and Applications in Mechanical Components, Jose Luis Otegui, Springer, 2016

Subject Name: Failure Mechanism & Analysis Subject Code: BTCMTPEC702 Subject Credit: 3

Objectives of the course

- To study the different types of fatigue failures and their mechanisms in the engineering applications
- To study the basic theory of fracture mechanics and its relationship with fatigue and creep failure mechanisms
- To understand the damage tolerance approach in the life estimation of structures

Course Outcomes

After completing this course, the student will be:

- able to identify the characteristic fatigue failures and fracture in the engineering structures.
- able to gain knowledge about the various concepts and theory of fatigue and fracture mechanics.

Course Contents

Module 1: Introduction and historical overview, Types of fatigue – low cycle fatigue, high cycle fatigue, very high cycle (giga cycle) fatigue, Fatigue test methods and equipment, Total life approaches based on cyclic stress and cyclic strain, Cyclic hardening and softening in single crystals and polycrystals **(10 hours)**

Module 2: Types of fracture, Theoretical Cohesive strength, Griffith theory of brittle fracture, Stress Intensity Factor, Fracture toughness and design, Determination of plane strain fracture toughness, J integral, R curve **(10 hours)**

Module 3: Crack initiation and propagation, Mechanisms, Crack Opening Displacement, Macrostructural and microstructural aspects, Use of fracture mechanics **(10 hours)**

Module 4: Fatigue behaviour of different materials – Metallic materials and weldments, Ceramics, Polymers, Composites, Metallic glasses, Shape memory alloys, Ultrafine grained materials, Nanocrystalline materials, Biomaterials, Metallic foams Case studies on fatigue failures, Design considerations, Methods for fatigue life improvement **(10 hours)**

Suggested books

1. Fatigue of Materials, Suresh, Cambridge India, 2015
2. Fracture Mechanics, Fundamentals and Applications, T.L. Anderson, CRC Press 2017
3. Mechanical Metallurgy by G.E. Dieter

Subject Name: Principles of X-Ray Diffraction Subject Code: BTCMTOEC701 Subject Credit: 3

Course objective: To study the principles, theory and practice of X-Ray Diffraction (XRD) techniques.

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

- Understand theory and principles of XRD analysis.
- Determine crystal structures.
- Carry out indexing of an XRD pattern.
- Measure Lattice parameter, texture, residual stress and determine the solvus.

Course Content

Module 1: Generation of X-Ray. Continuous and characteristic spectrum of X-ray. Filters. Coherent scattering and diffraction under nonideal conditions. Intensity of diffracted beams, Laue & Powder method. Indexing of cubic and non-cubic crystals, Diffractometer techniques. **(16 hours)**

Module 2: Standard projection. Reciprocal lattice concepts. **(8 hours)**

Module 3: Application: Precise Lattice parameter determination, solvus determination, chemical analysis, particle size determination, residual stress measurement **(16 hours)**

Suggested Reading:

1. Elements of X-Ray Diffraction - B. D. Cullity and S. R. Stock

2. X-Ray Diffraction: A Practical Approach - C. Suryanarayana and M. Grant Norton

Subject Name: Principles of Electron Microscopy **Subject Code: BTCMTOEC702** **Subject Credit: 3**

Course objective: To study the principles, theory and practice of electron microscopy.

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

- Understand theory and principles of Scanning Electron Microscopy (SEM) and Transmission Electron Microscopy (TEM)
- Study the structures under SEM and TEM

Course Content

Module 1: Introduction, comparison of light microscope and electron microscopes, imaging. **(8 hours)**

Module 2: SEM - principles of operation, Instrumentation **(16 hours)**

Module 3: TEM - Instrumentation, Basics of Diffraction, Imaging and Spectroscopy **(16 hours)**

Suggested reading:

1. Scanning Electron Microscopy and X-Ray Microanalysis: A Textbook for Biologists, Materials Scientists and Geologists by J.I. Goldstein, A.D. Romig, D.E. Newbury, C.E. Lyman, P. Echlin, C. Fiori, D.C. Joy and E. Lifshin

2. Transmission Electron Microscopy: A Textbook for Materials Science by David B Williams and C. Barry Carter

Subject Name: Quality Assurance and Quality Control **Subject Code: BTCMTOEC703** **Subject Credit: 3**

Course Objectives

To develop awareness among the students of the importance of quality, its analysis and quantification, and various techniques used to improve quality.

Course Outcomes

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

- Have a broad overview of the importance of quality in an industrial set-up.
- Apply various tools and techniques to analyze quality issues.
- Suggest suitable methods to improve quality.

Course Contents

Module 1: Introduction to quality, Objectives of Quality control and Quality assurance, Cost of quality **(2 hours)**

Module 2: Total Quality Management (TQM framework, PDSA cycle, Benchmarking, MBNQA model, Leadership, Customer satisfaction, Continuous process improvement, KAIZEN, Total Productive Maintenance (TPM)) **(4 hours)**

Module 3 : Quality by Design (Quality function deployment, FMEA, Product Development Cycle, Customer needs) **[2 hours]**

Module 4 : Control of Purchased Product and Manufacturing Quality (Procurement process, Sourcing strategies, Evaluation of suppliers, Capacity verification, Development of sources, Steps for quality manufacturing, Inspection and control of products, Product liability, After-sales service, Guarantee vs warrantee) **(4 hours)**

Module 5: Quality Management (Quality functions, Quality cost optimization, Cost reduction programs, Process control, Statistical Process Control (SPC), Troubleshooting, Human factors and corrective methods) **(5 hours)**

Module 6: Control Charts (Central tendency, Range and Standard Deviation, X-Bar and R charts, P charts, C charts, Sampling plans) **(3 hours)**

Module 7: Defects Diagnosis and Prevention (Defect study, Product quality, Maintainability, Failures, Concept of Reliability, Zero defect program, Quality Circles) **(4 hours)**

Module 8: Quality Management System (Quality Policy, Quality Assurance, ISO 9000, Quality audit, Steps to implement ISO 9000, Quality records) **(4 hours)**

Module 9: Taguchi Quality Method and JIT (Taguchi Quality Lost Function, Just-In-Time (JIT) and its implementation) **(3 hours)**

Module 10: ISO-14000 QMS and Quality Audit (Overview of ISO-14000 systems, Audit plan, Auditing procedure, Audit report, Non-conformance and corrective action) **(3 hours)**

Module 11: Production Planning and Control (PPC information requirement, Production cycle, PPC organization) **(2 hours)**

Module 12: Predictive Maintenance (PDM) and Spare Parts Management (SPM) (Condition monitoring, NDT, Inventory analysis and control, ABC analysis, VED analysis, SDE analysis) **(3 hours)**

Module 13: Pareto Analysis (Principle, Pareto analysis in decision making), SWOT analysis) **(2 hours)**

Module 14: Value Engineering (Objective, Function, Product Life Cycle, Matrix method in VE) **(2 hours)**

Module 15: Process improvements and six sigma **(2 hours)**

Suggested Books

- Quality Management by O N Pandey and Bhupesh Aneja, Katson Books, 2017
- Quality Management by Kanishka Bedi, Oxford Higher Education, 2006
- Total Quality Management by P N Mukherjee, PHI, 2006

Subject Name: Optimization Techniques **Subject Code: BTCMTOEC704** **Subject Credit: 3**

Course Objectives

To make the students become familiar with the basic Principle of LPP and enrich knowledge to formulate and solve an LPP using various methods.

To Impart knowledge on theory of optimization and conditions for optimality for unconstraint and constraint optimization problems

To Familiarize with the working principle of optimization algorithms used to solve linear and non-linear problems

Course Outcomes

At the end of this course, the student will be able to

Comprehend the techniques and applications of Engineering optimization.

Analyze characteristics of a general linear programming problem.

Apply basic concepts of mathematics to formulate an optimization problem.

Analyse various methods of solving the unconstrained minimization problem.

Analyze and appreciate variety of performance measures for various optimization problems.

Course Contents

Module 1: Introduction-Historical Development, Engineering Applications, Statement and Problem definition, Classification and techniques of optimization, Classical optimization techniques.

Module 2: Linear Programming (L.P): Graphical method, Simplex method, Revised simplex method, Duality in linear programming, Sensitivity analysis, other algorithms for solving LP problems, transportation, assignment and other applications.

Module 3: Non-linear Programming (N.L.P)- one dimensional search, unconstrained optimization tech-gradient approach, steepest descent method, constrained problem- penalty function method, Lagrangian method.

Module 4: Dynamic programming- multistage decision process, principle of optimality, computational procedure in Dynamic programming.

Module 5: Other topics in optimization- Queuing theory, Game theory, Optimal control theory, Calculus of variation, Multiobjective optimization, Introduction to genetic algorithm, Case Studies.

Textbooks:

1. Kanti Swarup, Gupta, P.K and Man Mohan, “Operation Research”, Sultan Chand, 11th Edition, 2003.
2. S.D. Sharma, “Operations Research-Theory Methods & Applications”, Kedar Nath Ram Nath Publisher, 2020 Edition
3. Rao, S.S., “Optimization: Theory and Applications”, Wiley Eastern.
4. David E. Goldberg, “Genetic Algorithms in Search, Optimization & Machine Learning “, Addison Wesley Publishing Company, Inc.

Subject Name: Soft Skill Development **Subject Code: BTCMTLC701** **Subject Credit: 1**

Laboratory Objectives:

Training students to make them conversant with different Soft Skill Development Methods.

Laboratory Outcomes:

1. Students will be able to communicate in English confidently.
2. Students will be able to communicate appropriately in professional and social situations.
3. Students will be able to improve team working, leadership skills and problem-solving skills through group activities like GD, case studies, Role play etc.
4. Students will be able to organize and write properly and correctly business correspondence.
5. Students will be able to do active listening.

Module 1: Speaking Skills

GD, Debate, Public Speaking: Concept of GD, Its uses, dos and don'ts of GD and understanding the soft Skills related to GD, teaching strategies of GD with the help of Language lab audio & video devices, Case studies to be practiced to enhance problem solving ability, Understanding the importance of non-verbal communication – body language and right posture and gestures, Exploring Live/ Recorded GD sessions for mending students' attitude/ approach & taking remedial measures. Concept of Public speaking and practice. Organizing Debate.

Module 2: Writing Skills

Business Correspondence and CV, Discussion on the difference between CV and Resume, Understanding the need for CV/ Resume as per industry requirements, Grammar and paragraph writing for WAT (Writing Ability Test).

Module 3: Presentation

Teaching presentation as a skill, Basics of preparing a presentation, means of presentation and how to deliver it – Individual and group presentation.

Module 4: Role Plays

Using situational dialogues and role plays to help students understand how to communicate in various formal and informal situations and develop their communicative ability, Group role plays to understand group dynamics and build team skills and leadership skills.

Module 5: Listening Skills

Teaching students the importance and concept of active listening through various Language lab audio related activities.

Module 6: Etiquette

Teaching students the need for proper etiquette, Discussions on etiquette, email etiquette, interview etiquette, telephone etiquette, formal office etiquette.

Module 7: Mock Interview

Teaching student various dos and don’ts of an interview through audio visual aid. Helping them understand the soft skills needed in an interview and developing them through participation in mock interview sessions.

Reference Materials:

1. Raman and Sharma, Technical Communication, Oxford University Press.
2. Ghanekar, A., Business Communication Skills, Everest Publishing House.
3. Konar N., Language Lab Manual, Prentice Hall.

8th Semester

Subject Name: Advance Materials **Subject Code: BTCMTOEC801** **Subject Credit: 3**

Course Objectives:

To impart basic knowledge on the response of the materials under static/dynamic loading at different temperatures.

Course Outcomes:

The students will have insights on the basic deformation behavior of various materials.

They will be able to make the right choice of material for a given loading conditions.

Course Contents

Module I

Basics of electronics, magnetic and optical properties of materials- Origin of these properties in metals, semiconductors, ceramics and polymers; Electronic properties- basics, study of conductivity, dielectric properties, etc. in materials; Concept of doping- Charge carriers, Dielectric properties of materials in the high, very high and ultra-high frequency fields; Organic semiconductors, Inorganic semiconductors; Basic structural characteristics and properties of -conjugated polymers-Important -conjugated polymers, Electrical conductivity, Photoconductivity, Charge storage capacity, Photoluminescence, Electroluminescence [7 Hours]

Module II

Magnets: Magneto statics, Origin of magnetism in materials, Magnetic domains and domain walls, Magnetic anisotropy, Reversible and irreversible magnetization processes; Hard and soft magnetic materials and magnetic recording; Amorphous and nanocrystalline magnetic materials; Magnetic properties of thin films, Nanoparticles-amorphous and nanocrystalline magnetic materials, Magnetoresistive materials; Magnetically active polymers- Ferromagnetism in polymers, Iron, nickel, cobalt, Ruthenium, Osmium containing magnetic polymers, Magnetic polymers with conductivity [7 Hours]

Module III

Optical properties of semiconductors, Dielectrics and polymers; Ray optics, Electromagnetic optics and guided wave optics; Physics of light-matter interactions; LEDs, Lasers, Photodetectors, Modulators, Optical filters, and photonic crystals; Photoactive polymers-Radiation sensitive resisters, Optical properties of conjugated and non-conjugated polymers, Relaxation process in organic polymer systems, Light emission in polymers, Polymeric materials for nonlinear optical properties- photorefractive polymers, polymers with high two photonactivities, Device design principles: LEDs, lasers, photo-detectors, etc. [7 Hours]

Module IV

Electro active applications: Conductivity applications, Electronic applications- EMI shielding, Frequency selective surfaces, Satellite communication links; Applications include diodes, Transistors, Photodetectors, Solar cells (photovoltaics), Displays, Lasers, Optical fibers and optical communications, Photonic devices, Magnetic data storage and Spintronics; Applications of polymers to electroluminescence, Light emitting diodes, Optical switches, Optical fiber applications [8 Hours]

Module V

Smart materials and structures: System intelligence- components and classification of smart structures, common smart materials and associated stimulus-response, Application areas of smart systems Ferroelectric materials: Piezoelectric materials- piezoelectric effect, Direct and converse, parameter definitions, Piezoceramics, Piezopolymers, Piezoelectric materials as sensors, Actuators and bimorphs Shape memory materials: Shape memory alloys (SMAs), Shape memory effect, Martensitic transformation, One way and two-way SME, training of SMAs, binary and ternary alloy systems, Functional properties of SMAs [7 Hours]

Module VI

Chromogenic materials: Thermochromism, Photochromism, Electrochromism, Halochromism, Solvatochromism- principle and design strategies Smart polymers: Thermally responsive polymers, Electroactive polymers microgels, Synthesis, Properties and Applications, Protein-based smart polymers, pH-responsive and photo-responsive polymers, Self-assembly, Molecular imprinting using smart polymers, Approaches to molecular imprinting, Drug delivery using smart polymers [6 Hours]

Module VII

Smart hydrogels: Synthesis, Fast responsive hydrogels, Molecular recognition, Smart hydrogels as actuators, Controlled drug release, Artificial muscles, Hydrogels in microfluidics Smart systems for space applications: Elastic memory composites, Smart corrosion protection coatings, Self-healing materials, Sensors, Actuators, Transducers, MEMS, Deployment devices, Molecular machines [4 Hours]

Books

1. D.J. Leo, Engineering Analysis of Smart Material Systems, Wiley 2007.

2. M. Addington, D.L. Schodek, Smart Materials and New Technologies in Architecture, Elsevier2005.

3. K. Otsuka, C.M. Wayman (Eds.), Shape Memory Materials, Cambridge University Press, 1998.

4. M.V. Gandhi, B. S. Thompson, Smart Materials and Structures, Chapman & Hall, 1992.

5. M. Schwartz, New Materials, Processes, and Methods Technology, CRC Press, 2006.

6. P. Ball,Made to Measure: Materials for the 21stCentury, Princeton University Press, 1997.

7. I. Galaev, B. Mattiasson (Eds.), Smart Polymers: Applications in Biotechnology and Biomedicine, 2nd ed., CRC Press, 2008.

8. N. Yui, R. J. Mrsny, K. Park (Eds.), Understanding and Designing Fast Responsive Polymeric Systems, CRC Press, 2004.

9. T.A. Skotheim, R.L. Elsenbaumer, J.R. Reynolds, Hand Book of Conducting Polymers, 2nd ed., Marcel Dekker, New York, Vol.1-2, 1998.

10. S.O. Kasap, Optoelectronics and Photonics: Principles and Practices, Pearson Education, 2009

11. J. L. Bredas, R. Silbey, Conjugated Polymers, Kluwer, Dordrecht, 1991.

12. M. Bikales, Overberger, Menges, Encyclopaedia of Polymer Science and Engineering, 2nd ed., Vol.5, John Wiley & Sons, 1986.

13. C.P. Wong, Polymers for Electronic and Photonic Applications, Academic Press, 1993.

14. J. David, Introduction to Magnetism and Magnetic Materials, 2nd ed., Chapman & Hall, 1998.

15. S.O. Kasap, P. Capper, Handbook of Electronic and Photonic Materials, Springer, 2006.

Subject Name: Functional Materials **Subject Code: BTCMTOEC802** **Subject Credit: 3**

Objectives

1. To provide the students with a detailed understanding (synthesis/growth, structure, and properties) of the functional materials.

2. To develop an understanding of the usage of functional materials as a component for versatile modern devices and applications.

Learning Outcomes

The students will be able to:

1. Compare, correlate and investigate the different synthesis, characterization, and application of exemplar functional materials.

2. Integrate the understanding of functional materials' properties and their applications.

Course Contents

Module I: Material synthesis and processing of functional materials: Bulk Synthesis: Solid state synthesis, Sol-Gel synthesis, Thin-Film synthesis: Sputtering, Molecular beam epitaxy, CVD, 3D printing, electrospinning. **(8 hours)**

Module II: Defects in solids: Defect types and dimensionality effect on defects, Characterization (morphological and spectroscopic), Control of defects. **(8 hours)**

Module III: Semiconductor materials: Band structure, Doping, Band-Gap engineering. **(4 hours)**

Module IV: Applications: Beyond Si semiconductors, GaN, GaAs, SiC, Ga2O3, LEDs, and photovoltaic cells (CdS, CIGS, CZTS, Perovskites and Organic solar cell materials). **(6 hours)**

Module V: Materials for energy applications: Thermoelectric materials: ZT value, Band-Gap, Conductivity engineering, Oxide materials, Heusler alloys, Artificial and hierarchical materials, Peltier cooling, Thermoelectric generator, Dielectric, Piezoelectric, Ferroelectric materials and applications **(8 hours)**

Module VI: Magnetic materials & applications: Magnetic exchange energy, anisotropy energy, Magnetic domains, Application of soft and hard magnetic materials, Magnetic data storage, Superconductors in electronics. **(6 hours)**

Module VII: Optical materials: Optical lithography, and applications, Electro-optic materials. **(6 hours)**

Textbook

1. Askeland, D.R., Phule, P.P., Wright, W.J., The Science and Engineering of Materials, 6th edition, Cengage Learning, 2010.

2. Callister, W.D., Rethwisch, D.G., Materials science and Engineering: An Introduction, 8th edition, Wiley, 2010.

3. Mitchell, B.S., An Introduction to Materials Engineering and Science for Chemical and Materials Engineers, 1st ed., Wiley- Interscience, 2003.

4. Kittel, C., Introduction to Solid State Physics, 8th edition, Wiley, 2005.

Reference Books

1. Kasap, S.O., Principles of Electronic Materials and Devices, 3rd edition, McGraw-Hill, 2006.

2. Raghavan, V., Materials Science & Engineering: A first course, 5th edition, PHI Learning, 2004.

Online Course Material

1. Haridoss, P., Physics of Materials, NPTEL Course Material, Department of Metallurgy & Material Science, Indian Institute of Technology Madras, https://nptel.ac.in/courses/113/106/113106039/.

2. Garg, A., Electroceramics, NPTEL Course Material, Department of Material Science & Engineering, Indian Institute of Technology Kanpur, https://nptel.ac.in/courses/113/104/113104005/.