REVA UNIVERSITY
Bengaluru, India

SCHOOL OF MECHANICAL ENGINEERING

B.Tech

in

Mechanical Engineering

HAND BOOK

2018-22

Rukmini Knowledge Park
Kattigenahalli, Yelahanka, Bengaluru – 560064
www.reva.edu.in

School of Mechanical Engineering

B.Tech. in Mechanical Engineering

HANDBOOK

2018-19

Approved by

BOS/ME/BME/2017-18/05/06-06-2018

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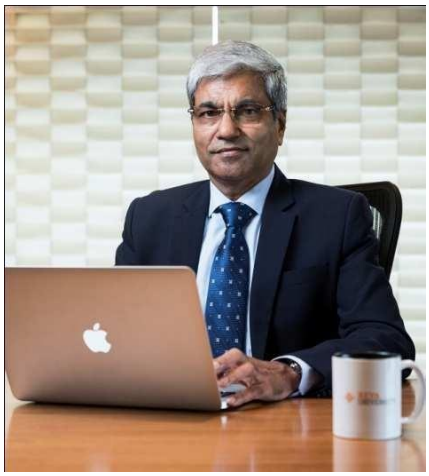
Chancellor's Message



"Education is the most powerful weapon which you can use to change the world."
- Nelson Mandela.

There was a time when survival depended on just the realization of physiological needs. We are indeed privileged to exist in a time when 'intellectual gratification' has become indispensable. Information is easily attainable for the soul that is curious enough to go look for it. Technological boons enable information availability anywhere anytime. The difference, however, lies between those who look for information and those who look for knowledge.

It is deemed virtuous to serve seekers of knowledge and as educators it is in the ethos at REVA University to empower every learner who chooses to enter our portals. Driven by our founding philosophy of 'Knowledge is Power', we believe in building a community of perpetual learners by enabling them to look beyond their abilities and achieve what they assumed impossible.

India has always been beheld as a brewing pot of unbelievable talent, acute intellect and immense potential. All it takes to turn those qualities into power is a spark of opportunity. Being at a University is an exciting and rewarding experience with opportunities to nurture abilities, challenge cognizance and gain competence.

For any University, the structure of excellence lies in the transitional abilities of its faculty and its facility. I'm always in awe of the efforts that our academic board puts in to develop the team of subject matter experts at REVA. My faculty colleagues understand our core vision of empowering our future generation to be ethically, morally and intellectually elite. They practice the art of teaching with a student-centered and transformational approach. The excellent infrastructure at the University, both educational and extra-curricular, magnificently demonstrates the importance of ambience in facilitating focused learning for our students.

A famous British politician and author from the 19th century - Benjamin Disraeli, once said 'A University should be a place of light, of liberty and of learning'. Centuries later this dictum still inspires me and I believe, it takes team-work to build successful institutions. I welcome you to REVA University to join hands in laying the foundation of your future with values, wisdom and knowledge.

Dr. P. Shyama Raju
The Founder and Hon'ble Chancellor, REVA University

Vice-Chancellor's Message

The last two decades have seen a remarkable growth in higher education in India and across the globe. The move towards inter-disciplinary studies and interactive learning have opened up several options as well as created multiple challenges. India is at a juncture where a huge population of young crowd is opting for higher education. With the tremendous growth of privatization of education in India, the major focus is on creating a platform for quality in knowledge enhancement and bridging the gap between academia and industry.

A strong believer and practitioner of the dictum "Knowledge is Power", REVA University has been on the path of delivering quality education by developing the young human resources on the foundation of ethical and moral values, while boosting their leadership qualities, research culture and innovative skills. Built on a sprawling 45 acres of green campus, this 'temple of learning' has excellent and state-of-the-art infrastructure facilities conducive to higher teaching-learning environment and research. The main objective of the University is to provide higher education of global standards and hence, all the programs are designed to meet international standards. Highly experienced and qualified faculty members, continuously engaged in the maintenance and enhancement of student-centric learning environment through innovative pedagogy, form the backbone of the University.

All the programs offered by REVA University follow the Choice Based Credit System (CBCS) with Outcome Based Approach. The flexibility in the curriculum has been designed with industry-specific goals in mind and the educator enjoys complete freedom to appropriate the syllabus by incorporating the latest knowledge and stimulating the creative minds of the students. Bench marked with the course of studies of various institutions of repute, our curriculum is extremely contemporary and is a culmination of efforts of great think-tanks - a large number of faculty members, experts from industries and research level organizations. The evaluation mechanism employs continuous assessment with grade point averages. We believe sincerely that it will meet the aspirations of all stakeholders – students, parents and the employers of the graduates and postgraduates of REVA University.

At REVA University, research, consultancy and innovation are regarded as our pillars of success. Most of the faculty members of the University are involved in research by attracting funded projects from various research level organizations like DST, VGST, DBT, DRDO, AICTE and industries. The outcome of the research is passed on to students through live projects from industries. The entrepreneurial zeal of the students is encouraged and nurtured through EDPs and EACs.

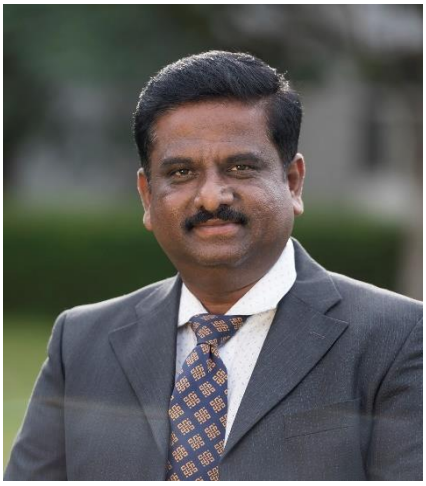
REVA University has entered into collaboration with many prominent industries to bridge the gap between industry and University. Regular visits to industries and mandatory internship with industries have helped our students become skilled with relevant to industry requirements. Structured training programs on soft-skills and preparatory training for competitive exams are offered here to make students more employable. 100% placement of eligible students speaks the effectiveness of these programs. The entrepreneurship development activities and establishment of "Technology Incubation Centers" in the University extend full support to the budding entrepreneurs to nurture their ideas and establish an enterprise.

With firm faith in the saying, "Intelligence plus character –that is the goal of education" (Martin Luther King, Jr.), I strongly believe REVA University is marching ahead in the right direction, providing a holistic education to the future generation and playing a positive role in nation building. We reiterate our endeavor to provide premium quality education accessible to all and an environment for the growth of over-all personality development leading to generating "GLOBAL PROFESSIONALS".

Welcome to the portals of REVA University!

Dr. S. Y. Kulkarni
Vice-Chancellor, REVA University

Director's Message



It's my pleasure to welcome you to the School of Mechanical Engineering. Mechanical Engineering is one of the major disciplines of engineering that applies the principles of physics and material science for analyzing, design, manufacturing and maintenance of mechanical systems. It plays a key role in energy, transportation, infrastructure development and manufacturing of products from house hold components to highly critical components. The program is designed to develop basic knowledge, skill and advanced technology in the field of mechanical engineering to the students to work in an industry or solve the problems of the society. Many of the courses in the program are developed on the basis of industry relevant and requirement, higher studies and competitive exams like GATE, IAS, IES etc,. Students have choices to choose the courses based on their interest and future plans. Some of the courses are project based and integrated with practical component to acquire additional skills. Few software courses are introduced in the program to enhance the job opportunities in the IT sector.

This handbook presents the B.Tech curriculum. The course is of 4 years duration and split into 8 semesters. A student has to earn 192 credits to obtain the award, where credits are spread across the semesters. These credits are split among foundation core, hard core, and soft core courses. Soft core courses provide flexibility to students to choose the options among several courses as per the specialization, such as, Thermal Engineering, Design, Manufacturing, and Management.

The curriculum caters to and has relevance to local, regional, national, global developmental needs. Maximum number of courses are integrated with cross cutting issues with relevant to professional ethics, gender, human values, environment and sustainability.

The important features of the B.Tech Mechanical Engineering are as follows.

1. Choice based course selection and teacher selection.
2. Studies in emerging areas like Automobile Engineering, FEM, Vibrations, Advanced Materials, MEMS, Robotics, R&AC, Cryogenics, CFD, Electric & Hybrid Vehicles, Machine Learning, Artificial Intelligence, Data Analytics, Python Programming, Additive Manufacturing.
3. Short and long duration Internships.
4. Opportunity to pursue MOOC course as per the interest.
5. Self-learning components.
6. Experiential, Practice, Practical, and project based learning.
7. Mini projects and Major projects.
8. Soft skills and Skill development courses.

School is having well qualified and experienced faculty with specialization in the field of thermal, design, manufacturing and management stream. There are well equipped laboratories and research centre to provide hands on experience on mechanical devices and equipments which will impart practical knowledge. Training and remedial classes will be conducted to enhance additional skills and basic knowledge.

I am sure that students choosing B.Tech. in Mechanical Engineering will enjoy the curriculum, teaching and learning environment, vast infrastructure and teachers involvement and guidance.

I wish all students pleasant stay in REVA and grand success in their career.

Dr. K S. Narayanswamy
Director – School of Mechanical Engineering

CONTENTS

RUKMINI EDUCATIONAL CHARITABLE TRUST

It was the dream of late Smt. Rukmini Shyama Raju to impart education to millions of underprivileged children as she knew the importance of education in the contemporary society. The dream of Smt. Rukmini Shyama Raju came true with the establishment of Rukmini Educational Charitable Trust (RECT), in the year 2002. **Rukmini Educational Charitable Trust** (RECT) is a Public Charitable Trust, set up in 2002 with the objective of promoting, establishing and conducting academic activities in the fields of Arts, Commerce, Education, Engineering, Environmental Science, Management and Science & Technology, among others. In furtherance of these objectives, the Trust has set up the REVA Group of Educational Institutions comprising of REVA Institute of Technology & Management (RITM), REVA Institute of Science and Management (RISM), REVA Institute of Management Studies (RIMS), REVA Institute of Education (RIE), REVA First Grade College (RFGC), REVA Degree College (Evening), REVA Independent PU College at Kattigenahalli, Ganganagar and Sanjaynagar and now REVA University. Through these institutions, the Trust seeks to fulfill its vision of providing world class education and create abundant opportunities for the youth of this nation to excel in the areas of Engineering, Commerce, Management, Education, Arts and Science & Technology.

Every great human enterprise is powered by the vision of one or more extraordinary individuals and is sustained by the people who derive their motivation from the founders. The Chairman of the Trust is Dr. P. Shyama Raju, a developer and builder of repute, a captain of the industry in his own right and the Chairman and Managing Director of the DivyaSree Group of companies. The idea of creating these top notch educational institutions was born of the philanthropic instincts of Dr. P. Shyama Raju to do public good, quite in keeping with his support to other socially relevant charities such as maintaining the Richmond road park, building and donating a police station, gifting assets to organizations providing accident and trauma care, to name a few.

The Rukmini Educational Charitable Trust drives with the main aim to help students who are in pursuit of quality education for life. REVA is today a family of ten institutions providing education from PU to Post Graduation and Research leading to M. Phil and PhD degrees. REVA has well qualified experienced teaching faculty of whom majority are doctorates. The faculty is supported by committed administrative and technical staff. Over 14,000 students study various courses across REVA's three campuses equipped with exemplary state-of-the-art infrastructure and conductive environment for the knowledge driven community.

ABOUT REVA UNIVERSITY

REVA University has been established under the REVA University Act, 2012 of Government of Karnataka and notified in Karnataka State Gazette dated 27thFebruary, 2013. The University is empowered by UGC to award degrees any branch of knowledge under Sec.22 of the UGC Act. The University is a Member of Association of Indian Universities, New Delhi. The main objective of the University is to prepare students with knowledge, wisdom and patriotism to face the global challenges and become the top leaders of the country and the globe in different fields.

REVA University located in between Kempegowda International Airport and Bangalore city, has a sprawling green campus spread over 45 acres of land and equipped with state-of-the-art infrastructure that provide conducive environment for higher learning and research. The REVA campus has well equipped laboratories, custom-built teaching facilities, fully air-conditioned library and central computer centre, the well planned sports facility with cricket ground, running track & variety of indoor and outdoor sports activities, facilities for cultural programs. The unique feature of REVA campus is the largest residential facility for students, faculty members and supportive staff.

The University is presently offering 23 Post Graduate Degree programs, 20 Degree and PG Degree programs in various branches of studies and has 14000+ students studying in various branches of knowledge at graduate and post graduate level and 331 Scholars pursuing research leading to PhD in 18 disciplines. It has 900+ well qualified, experienced and committed faculty members of whom majority are doctorates in their respective areas and most of them are guiding students pursuing research leading to PhD.

The programs being offered by the REVA University are well planned and designed after detailed study with emphasis with knowledge assimilation, applications, global job market and their social relevance. Highly qualified, experienced faculty and scholars from reputed universities / institutions, experts from industries and business sectors have contributed in preparing the scheme of instruction and detailed curricula for this program. Greater emphasis on practice in respective areas and skill development to suit to respective job environment has been given while designing the curricula. The Choice Based Credit System and Continuous Assessment Graded Pattern (CBCS – CAGP) of education has been introduced in all programs to facilitate students to opt for subjects of their choice in addition to the core subjects of the study and prepare them with needed skills. The system also allows students to move forward under the fast track for those who have the capabilities to surpass others. These programs are taught by well experienced qualified faculty supported by the experts from industries, business sectors and such other organizations. REVA University has also initiated many supportive measures such as bridge courses, special coaching, remedial classes, etc., for slow learners so as to give them the needed input and build in them confidence and courage to move forward and accomplish success in their career. The University has also entered into MOUs with many industries, business firms and other institutions

seeking their help in imparting quality education through practice, internship and also assisting students' placements.

REVA University recognizing the fact that research, development and innovation are the important functions of any university has established an independent Research and Innovation division headed by a senior professor as Dean of Research and Innovation. This division facilitates all faculty members and research scholars to undertake innovative research projects in engineering, science & technology and other areas of study. The interdisciplinary-multidisciplinary research is given the top most priority. The division continuously liaisons between various funding agencies, R&D Institutions, Industries and faculty members of REVA University to facilitate undertaking innovative projects. It encourages student research projects by forming different research groups under the guidance of senior faculty members. Some of the core areas of research wherein our young faculty members are working include Data Mining, Cloud Computing, Image Processing, Network Security, VLSI and Embedded Systems, Wireless Censor Networks, Computer Networks, IOT, MEMS, Nano-Electronics, Wireless Communications, Bio-fuels, Nano-technology for coatings, Composites, Vibration Energies, Electric Vehicles, Multilevel Inverter Application, Battery Management System, LED Lightings, Renewable Energy Sources and Active Filter, Innovative Concrete Reinforcement, Electro Chemical Synthesis, Energy Conversion Devices, Nano-structural Materials, Photo-electrochemical Hydrogen generation, Pesticide Residue Analysis, Nano materials, Photonics, Nana Tribology, Fuel Mechanics, Operation Research, Graph theory, Strategic Leadership and Innovative Entrepreneurship, Functional Development Management, Resource Management and Sustainable Development, Cyber Security, General Studies, Feminism, Computer Assisted Language Teaching, Culture Studies etc.

The REVA University has also given utmost importance to develop the much required skills through variety of training programs, industrial practice, case studies and such other activities that induce the said skills among all students. A full-fledged Career Development and Placement (CDC) department with world class infrastructure, headed by a dynamic experienced Professor & Dean, and supported by well experienced Trainers, Counselors and Placement Officers.

The University also has University-Industry Interaction and Skill Development Centre headed by a Senior Professor & Director facilitating skill related training to REVA students and other unemployed students. The University has been recognized as a Centre of Skill Development and Training by NSDC (National Skill Development Corporation) under Pradhan Mantri Kaushal Vikas Yojana. The Centre conducts several add-on courses in challenging areas of development. It is always active in facilitating student's variety of Skill Development Training programs.

The University has collaborations with Industries, universities abroad, research institutions, corporate training organizations, and Government agencies such as Florida International University, Oklahoma State University, Western Connecticut University, University of Alabama, Huntsville, Oracle India Ltd, Texas Instruments,

Nokia University Relations, EMC^2, VMware, SAP, Apollo etc, to facilitate student exchange and teacher–scholar exchange programs and conduct training programs. These collaborations with foreign universities also facilitates students to study some of the programs partly in REVA University and partly in foreign university, viz, M.S in Computer Science one year in REVA University and the next year in the University of Alabama, Huntsville, USA.

The University has also given greater importance to quality in education, research, administration and all activities of the university. Therefore, it has established an independent Internal Quality division headed by a senior professor as Dean of Internal Quality. The division works on planning, designing and developing different quality tools, implementing them and monitoring the implementation of these quality tools. It concentrates on training entire faculty to adopt the new tools and implement their use. The division further works on introducing various examination and administrative reforms.

To motivate the youth and transform them to become innovative entrepreneurs, successful leaders of tomorrow and committed citizens of the country, REVA organizes interaction between students and successful industrialists, entrepreneurs, scientists and such others from time to time. As a part of this exercise great personalities such as Bharat Ratna Prof. C. N. R. Rao, a renowned Scientist, Dr. N R Narayana Murthy, Founder and Chairman and Mentor of Infosys, Dr. K Kasturirangan, Former Chairman ISRO, Member of Planning Commission, Government of India, Dr. Balaram, Former Director IISc., and noted Scientist, Dr. V S Ramamurthy, Former Secretary, DST, Government of India, Dr. V K Aatre, noted Scientist and former head of the DRDO and Scientific Advisor to the Ministry of Defence Dr. Sathish Reddy, Scientific Advisor, Ministry of Defence, New Delhi and many others have accepted our invitation and blessed our students and faculty members by their inspiring addresses and interaction.

As a part of our effort in motivating and inspiring youth of today, REVA University also has instituted awards and prizes to recognize the services of teachers, researchers, scientists, entrepreneurs, social workers and such others who have contributed richly for the development of the society and progress of the country. One of such award instituted by REVA University is **'Life Time Achievement Award'** to be awarded to successful personalities who have made mark in their field of work. This award is presented on occasion of the **"Founders' Day Celebration"** of REVA University on 6th January of every year in presence of dignitaries, faculty members and students gathering. The first "REVA Life Time Achievement Award" for the year 2015 has been awarded to Shri. Kiran Kumar, Chairman ISRO, followed by Shri. Shekhar Gupta, renowned Journalist for the year 2016, Dr K J Yesudas, renowned play back singer for the year 2017. REVA also introduced "**REVA Award of Excellence"** in the year 2017 and the first Awardee of this prestigious award is Shri Ramesh Aravind, Actor, Producer, Director, Screen Writer and Speaker.

REVA organises various cultural programs to promote culture, tradition, ethical and moral values to our students. During such cultural events the students are given opportunities to unfold their hidden talents and motivate them to contribute innovative ideas for the progress of the society. One of such cultural events is

REVAMP conducted every year. The event not only gives opportunities to students of REVA but also students of other Universities and Colleges. During three days of this mega event students participate in debates, Quizzes, Group discussion, Seminars, exhibitions and variety of cultural events. Another important event is Shubha Vidaaya, - Graduation Day for the final year students of all the programs, wherein, the outgoing students are felicitated and are addressed by eminent personalities to take their future career in a right spirit, to be the good citizens and dedicate themselves to serve the society and make a mark in their respective spheres of activities. During this occasion, the students who have achieved top ranks and won medals and prizes in academic, cultural and sports activities are also recognized by distributing awards and prizes. The founders have also instituted medals and prizes for sports achievers every year. The physical education department conducts regular yoga classes everyday to students, faculty members, administrative staff and their family members and organizes yoga camps for villagers around.

Recognizing the fast growth of the university and its quality in imparting higher education, the BERG (Business Excellence and Research Group), Singapore has awarded BERG Education Award 2015 to REVA University under Private Universities category. The University has also been honoured with many more such honors and recognitions.

About the School of Mechanical Engineering

Mechanical Engineering is one of the oldest and classical branches of engineering which drives the development and economy of the country .The school of Mechanical Engineering in REVA University has a rich blend of experienced, energetic and dedicated faculty with highest qualification in the specialization of thermal, design, manufacturing and management streams. The school has well furnished class rooms and well equipped laboratories with modern software tools to meet academic and industry requirements. The research centre with modern equipments and testing facility is also available to cater research activities in the field of materials and bio-fuels. Extracurricular and co curricular activities are conducting to develop additional skills, knowledge and confidence through University Industry Interaction Cell and various student clubs and student chapters with the support of industries. Industry persons are invited to give technical talks on latest technologies and students are deputed for internship in industries and universities in India and Abroad. The school is having MOU with reputed industries and universities in India and abroad for internship, research and twinning program or higher studies which will give more exposure of our students to outside world. Many students have done internship in reputed institutions like IISc, ISRO, DRDO, HAL, Rail Wheel factory, Volvo and many more. Every semester school is organizing industry visits to reputed organizations to learn various aspects of industry. Student clubs and chapters are highly active in the school which are MARS, ISHRAE Student Chapter, Foundry Man Society, Fluid Power Society, SAE club and Aryan Racing Team through which cultural events, training programs, invited talks, industry visits and placement activities are conducting. School is encouraging the students to participate in national and international level competitions like Solar car design, Electric vehicle design, Formula car design, ATV design, Go-Cart design and quiz competition through this student can learn additional skills like design, team management, time management and financial aspects. Additional training programs are conducting in the field of automobile, robotics, and manufacturing to impart skills with industry relevant. The School is organizing workshops, seminars, conferences and competitions in national and international level for the students, faculty and research scholars to enhance their skills and research trends. The school offers B.Tech in Mechanical Engineering, M.Tech in Machine design and PhD program. The curriculum of both UG and PG is designed to meet the needs of the society and industry for present and future. It also meets the requirements of higher studies in India and abroad and also for the requirement of competitive exams. In overall, school will support and make our students more disciplined, good human being and more responsible persons of the society.

VISION

"Aspires to be recognized globally for outstanding value based education and research leading to well-qualified mechanical engineers, who are innovative, entrepreneurial, successful in their career and committed to the development of the country."

MISSION

1. To impart quality education to the students and enhance their skills to make them globally competitive mechanical engineers.

2. To promote multidisciplinary study and cutting edge research and expand the frontiers of mechanical engineers profession.

3. To create state-of-art facilities with advanced technology for providing students and faculty with opportunities for innovation, application and dissemination of knowledge.

4. To prepare for critical uncertainties ahead for mechanical engineering and to face the challenges through clean, green and healthy solution.

5. To collaborate with industries, institutions and such other agencies nationally and internationally to undertake exchange programs, research, consultancy and to facilitate students and faculty with greater opportunities for individual and societal growth.

ADVISORY BOARD

Sl No.	Particulars of Members
1	Dr. N. V. Ravikumar Associate Professor, Department of Metallurgy & Materials Engineering, IIT Madras
2	Mr. K. N. Narsimha Murthy Chairman, Fluid Air Systems, Bangalore. Hon. Treasurer, Karnataka Small Scale Industries Association (KSSIA)
3	Prof. M. V. Krishna Murthy Former Professor Dept. Mechanical Engineering IIT Chennai, Madras, Former Director, VIT, Vellore
4	Mr. Praveen Kumar Jinde Scientist, NAL, Bangalore
5	Dr. K Ramachandra Former Director, GTRE, Bangalore CEO, NP-MICAV's National Design Research Forum The Institute of Engineers, Bangalore.
6	Prof. E. Abhilash Dept. Mechanical Engineering, King Khalid University Abha, Kingdom of Saudi Arabia.

"When a young man leaves the institution after a course of training, he should be clean in speech and habit with a correct sense of patriotism, loyalty to the country, aptitude for initiative, love for self help, appreciation of the value of time, respect for law and order, and a knowledge of the value of the right thinking and right living, sufficiently well-equipped to fall into a position in some business or other and be able to support himself."

--- Sir. M. Visvesvaraya

B.Tech. in Mechanical Engineering Program

PROGRAMME OVERVIEW

Mechanical Engineering is a discipline of engineering that applies the principles of physics and materials science for design, analysis, prototyping, manufacturing, and maintenance of mechanical systems. Mechanical engineering deals with inter conversion of thermal and mechanical power and the design, production, and operation of machines and tools. It is one of the oldest and broadest engineering disciplines.

The mechanical engineering field requires an understanding of core concepts including mechanics, kinematics, thermodynamics, materials science, and structural analysis. Mechanical engineers use these core principles along with tools like computer-aided engineering and product lifecycle management to design and analyze manufacturing plants, industrial equipment and machinery, heating and cooling systems, transport systems, aircraft, watercraft, robotics, medical devices and more.

Mechanical Engineering science emerged in the 19th century as a result of developments in the field of physics. The field has continually evolved to incorporate advancements in technology. Mechanical engineers today are pursuing developments in fields such as composites, mechatronics and micro and nano technology. Mechanical Engineering overlaps with aerospace engineering, civil engineering, electrical engineering, petroleum engineering and chemical engineering to varying amounts.

There is tremendous scope for mechanical engineers in automobile engineering, cement industry, steel, power sector, hydraulics, manufacturing plants, drilling and mining industry, petroleum, aeronautical, biotechnology and many more. Nowadays they are also increasingly needed in the environmental and bio-medical fields. There are exciting times ahead for mechanical engineers as transport technologies like hyper loop, electric vehicles, flying cars, drone technologies, intelligent system like robots and additive manufacturing including 3D printing are gaining importance.

A beginner in Mechanical Engineering can opt for various job openings such as: Design Engineer, CAE Analyst, Shop Floor Engineer, Production Planning, Quality Assurance, Maintenance Engineer, Safety Engineer, Production Supervisor/Engineer, R&D Trainee etc.

The School of Mechanical Engineering at REVA UNIVERSITY offers B. Tech., Mechanical Engineering–an undergraduate programme to create motivated, innovative, creative and thinking graduates to fill the roles of Mechanical Engineers who can conceptualize, design, analyse, develop and produce Mechanical Systems to meet the modern day requirements.

The B. Tech., in Mechanical Engineering curriculum developed by the faculty at the **School of Mechanical Engineering**, is outcome based and it comprises required theoretical concepts and practical skills in the domain. By undergoing this programme, students develop critical, innovative, creative thinking and problem solving abilities for a smooth transition from academic to real-life work environment. In addition, students are trained

in interdisciplinary topics and attitudinal skills to enhance their scope. The above mentioned features of the programme, advanced teaching and learning resources, and experience of the faculty members with their strong connections with manufacturing sector makes this programme unique.

PROGRAM EDUCATIONAL OBJECTIVES (PEOs)

The programme helps to develop critical, analytical, innovative, creative and problem solving abilities amongst its graduates. The programme makes the graduates employable as Mechanical Engineers in manufacturing, agriculture and service sectors. With further education and earning of higher level degrees help the graduates to pursue a career in academics or scientific organisations as researchers.

The Programme Educational Objectives are to prepare the students to:

1. be mechanical engineers to work in Manufacturing, Agriculture and Services sectors
2. act as administrators in public, private and government organisations with further training and education
3. pursue for higher degrees to work in colleges, universities as professors or as scientists in research establishments or business administrators
4. be conversant with environmental, legal, cultural, social, ethical, public safety issues
5. work as a member of a team as well as lead a team
6. communicate effectively across team members and work under constraints
7. set his/her own enterprise with further training
8. adopt lifelong learning philosophy for continuous improvement

PROGRAM OUTCOMES (POs)

After undergoing this programme, a student will be able to:

1. explain the principals involved in working and designing of modern mechanical systems
2. conceptualize, design, analyze, prototype and evaluate mechanical systems
3. perform detailed calculations to develop manufacturing, construction, and installation standards and specifications
4. choose appropriate materials, processes and direct the manufacture, installation, and testing of mechanical equipment to ensure that products meet specifications and codes
5. investigate complaints from customers or the public, evaluate problems, and recommend solutions
6. work with project managers on production efforts to ensure that projects are completed satisfactorily, on time, and within budget
7. use modern tools and techniques for design and development of mechanical systems
8. conform to cultural, environmental, sustainability and ethical issues
9. communicate across teams verbally, visually and by writing
10. Choose appropriate online programmes for further learning, participate in seminars and conferences

Program Specific Outcomes (PSOs)

a. On successful completion of the program, the graduates of B.Tech Mechanical Engineering will beable to:

- **PSO-1:** Apply mechanical engineering knowledge and skills in Design, Manufacturing, Thermaland Industrial Engineering to obtain realistic outcomes.
- **PSO-2:** Identify, formulate, analyze and solve problems in Mechanical Engineering and allieddomains.

PSO-3: Conduct investigations in Mechanical Engineering and allied areas to provide optimaland sustainable solutions.

B.Tech. in Mechanical Engineering Program
Scheme of Instructions and Detailed Syllabus
(Effective from 2018-19)

I SEMESTER (CHEMISTRY CYCLE)

Sl. No	Course Code	Title of the Course	Type of Course	Pre requisite	Credit Pattern & Credit Value					Contact Hours	Teaching school
					L	T	P	J	Total		
1	B18ME1010	Calculus	HC	---	2	1	0	0	3	4	Physical Sciences
2	B18ME1020	Applied Chemistry	HC	---	3	0	0	0	3	3	Physical Sciences
3	B18ME1030	Basic Electrical and Electronics Engineering	HC	---	2	0	1	0	3	5	EEE
4	B18ME1040	Computer Aided Engineering Drawing	HC	---	1	0	2	0	3	7	ME
5	B18ME1050	Environmental Studies	FC	---	2	0	0	0	2	2	Physical Sciences
6	B18ME1060	Technical English-I	FC	---	0	0	2	0	2	4	Humanity Science
7	B18ME1070	Applied Chemistry Lab	HC	---	0	0	2	0	2	3	Physical Sciences
8	B18ME1080	Workshop Practice	HC	---	0	0	2	0	2	3	ME
TOTAL CREDITS & CONTACT HOURS									**20**	**31**	

II SEMESTER (PHYSICS CYCLE)

Sl. No	Course Code	Title of the Course	Type of Course	Pre requisite	Credit Pattern & Credit Value					Contact Hours	Teaching School
					L	T	P	J	Total		
1	B18ME2010	Linear Algebra and Laplace Transform	HC	---	2	1	0	0	3	4	Physical Sciences
2	B18ME2020	Applied Physics	HC	---	3	0	0	0	3	3	Physical Sciences
3	B18ME2030	C Programming	HC	---	3	0	0	0	3	3	C&IT
4	B18ME2040	Manufacturing Technology	HC	---	3	0	0	0	3	3	ME
5	B18ME2050	Engineering Mechanics	HC		2	1	0	0	3	4	CE
6	B18ME2060	Constitution of India and Professional Ethics	FC	---	2	0	0	0	2	2	Legal Studies
7	B18ME2070	Technical English-II	FC	---	0	0	2	0	2	4	Humanity Science
8	B18ME2080	Applied Physics Lab	HC		0	0	2	0	2	3	Physical Sciences
9	B18ME2090	C Programming Lab	HC		0	0	2	0	2	3	C&IT
TOTAL CREDITS & CONTACT HOURS									**23**	**29**	
TOTAL CREDITS OF I SEMESTER TO II SEMESTER									**43**		

III SEMESTER

Sl. No	Course Code	Title of the Course	Type of Course	Pre requisite	Credit Pattern & Credit Value					Contact Hours	Teaching School
					L	T	P	J	Total		
1	B18ME3010	Numerical Methods and Probability	HC	18ME1010/ 2010	2	1	0	0	3	4	Physical Sciences
2	B18ME3020	Mechanics of Materials*	HC	18ME2020	3	0	1	0	4	5	ME
3	B18ME3030	Engineering Thermodynamics	HC	18ME1020	3	1	0	0	4	5	ME
4	B18ME3040	Fluids Mechanics and Fluid Machinery*	HC	18ME2020	2	0	1	0	3	4	ME
	Group-A										
5	B18ME3150	Material Science and Metallurgy	HC	18ME2020	3	0	0	0	3	3	ME
6	B18ME3160	Computer Aided Machine Drawing	HC	18ME1040	1	0	2	0	3	5	ME
7	B18ME3170	Materials Testing and Characterization Lab	HC	---	0	0	2	0	2	3	ME
8	B18ME3180	Casting & Forging Lab	HC	18ME2040	0	0	2	0	2	3	ME
	Group-B										
5	B18ME3250	Mechanical Measurements and Metrology	HC	18ME2020	3	0	0	0	3	3	ME
6	B18ME3260	Theory of Metal Cutting and Machine Tools	HC	----	3	0	0	0	3	3	ME
7	B18ME3270	Fluid Machinery Lab	HC	----	0	0	2	0	2	3	ME
8	B18ME3280	Metal Cutting and Machine Tool Lab	HC		0	0	2	0	2	3	ME
9	B18ME3090	Placement Training-1	FC		*0*	*0*	*2*	*0*	*2*	3	Placement
10	B18ME3X10	Sports/Yoga/Music/Dance/Theatre	RULO		*0*	*0*	*0*	*2*	*2*	---	Sports/Arts
TOTAL CREDITS & CONTACT HOURS									**28**	**35**	
TOTAL CREDITS OF I SEMESTER TO III SEMESTER									**71**		

Note: 1. Mechanics of Materials integrated with MAT Lab for practice session

2. Experiment on Losses in pipes and flow measurement is integrated with fluid mechanics & Fluid Machinery course, it should be done along with practice session of the theory.

3. Those who study Group A courses in III sem must study Group B courses in IV semester and those who study Group B courses in III sem must study Group A courses in IV semester

IV SEMESTER

Sl. No	Course Code	Title of the Course	Type of Course	Pre requisite	Credit Pattern & Credit Value					Contact Hours	Teaching School
					L	T	P	J	Total		
1	B18ME4010	Applied Mathematics	HC	18ME2010/ 3010	2	1	0	0	3	4	Physical Science
2	B18ME4020	Kinematics of Machines	HC	18ME2050	4	0	0	0	4	4	ME
3	B18ME4030	Applied Thermodynamics	HC	18ME1020	3	1	0	0	4	5	ME
	Soft Core -1										
4	B18ME4041	Internal Combustion Engines	SC	----	3	0	0	0	3	3	ME
	B18ME4042	Advanced Materials		----	3	0	0	0	3	3	ME
	B18ME4043	Plastic Engineering		---	3	0	0	0	3	3	ME
	B18ME4044	Principles of Management		----	3	0	0	0	3	3	ME
	B18ME4045	Object Oriented Programming with C++		18ME2030	2	0	1	0	3	4	C&IT
	Group-A										
5	B18ME4150	Material Science and Metallurgy	HC	18ME2020	3	0	0	0	3	3	ME
6	B18ME4160	Computer Aided Machine Drawing	HC	18ME1040	1	0	2	0	3	5	ME
7	B18ME4170	Materials Testing and Characterization Lab	HC	---	0	0	2	0	2	3	ME
8	B18ME4180	Casting and Forging Lab	HC	18ME2040	0	0	2	0	2	3	ME
	Group-B										
5	B18ME4250	Mechanical Measurements and Metrology	HC	18ME2020	3	0	0	0	3	3	ME
6	B18ME4260	Theory of Metal Cutting & Machine Tools	HC	----	3	0	0	0	3	3	ME
7	B18ME4270	Fluid Machinery Lab	HC	----	0	0	2	0	2	3	ME
8	B18ME4280	Metal Cutting and Machine Tool Lab	HC	----	0	0	2	0	2	3	ME
9	B18ME4090	Placement Training-2	FC		*0*	*0*	*2*	*0*	*2*	3	Placement
TOTAL CREDITS & CONTACT HOURS									**26**	**34**	
TOTAL CREDITS OF I SEMESTER TO IV SEMESTER									**97**		

Note: Those who studied Group A courses in III sem must study Group B courses in IV semester; Those who studied Group B courses in III sem must study Group A courses in IV semester

V SEMESTER

Sl. No	Course Code	Title of the Course	Type of Course	Pre requisite	Credit Pattern & Credit Value					Contact Hours	Teaching School
					L	T	P	J	Total		
1	B18ME5010	Design of Machine Elements	HC	18ME3020	3	1	0	0	4	5	ME
2	B18ME5020	Turbo Machines	HC	18ME3040	3	1	0	0	4	5	ME
3	**Soft Core -2**										
	B18ME5031	Power Plant Engineering	SC	----	3	0	0	0	3	3	ME
	B18ME5032	Composite Materials		----	3	0	0	0	3	3	ME
	B18ME5033	Hydraulics and Pneumatics		----	3	0	0	0	3	3	ME
	B18ME5034	Production Management		----	3	0	0	0	3	3	ME
	B18ME5035	Database Management System		----	2	0	1	0	3	4	C&IT
4	**Soft Core -3**										
	B18ME5041	Renewable Energy Resources	SC	----	3	0	0	0	3	3	ME
	B18ME5042	Theory of Elasticity		18ME3020	3	0	0	0	3	3	ME
	B18ME5043	Non Traditional Machining		18ME3260/4260	3	0	0	0	3	3	ME
	B18ME5044	Materials Management		----	3	0	0	0	3	3	ME
	B18ME5045	Java programming		----	2	0	1	0	3	4	C&IT
	Group-A										
5	B18ME5150	Dynamics of Machines	HC	18ME2050	3	1	0	0	4	5	ME
6	B18ME5160	Metal Forming Process	HC	----	3	0	0	0	3	3	ME
7	B18ME5170	Internal Combustion Engines Lab	HC	18ME4030	0	0	2	0	2	3	ME
8	B18ME5180	Design and Dynamics Lab	HC	----	0	0	2	0	2	3	ME
	Group-B										
5	B18ME5250	Heat Transfer	HC	**18ME3030/4030**	3	1	0	0	4	5	ME
6	B18ME5260	CAD/CAM/CIM	HC	----	3	0	0	0	3	3	ME
7	B18ME5270	Heat Transfer Lab	HC	----	0	0	2	0	2	3	ME
8	B18ME5280	CIM and Automation Lab	HC	----	0	0	2	0	2	3	ME
9	B18ME5090	Placement Training-3	FC	----	*0*	*0*	*2*	*0*	*2*	3	Placement
TOTAL CREDITS & CONTACT HOURS									**27**	**35**	
TOTAL CREDITS OF I SEMESTER TO V SEMESTER									**124**		

Note: Those who study Group A courses in V sem must study Group B courses in VI semester and those who study Group B courses in V sem must study Group A courses in IV semester

VI SEMESTER

Sl. No	Course Code	Title of the Course	Type of Course	Pre requisite	Credit Pattern & Credit Value					Contact Hours	Teaching School
					L	T	P	J	Total		
1	B18ME6010	Design of Transmission Elements	HC	18ME3020	3	1	0	0	4	5	ME
2		**Soft Core -4**									
	B18ME6021	Bio-Mass Energy System	SC	----	3	0	0	0	3	3	ME
	B18ME6022	Mechanics of Composite Materials		18ME5032	3	0	0	0	3	3	ME
	B18ME6023	Robotics		----	3	0	0	0	3	3	ME
	B18ME6024	Theory of Plasticity		18ME3020	3	0	0	0	3	3	ME
	B18ME6025	Machine Learning Program using Python		----	2	0	1	0	3	4	C&IT
3		**Soft Core -5**									
	B18ME6031	Refrigeration and Air conditioning	SC	18ME4030	3	0	0	0	3	3	ME
	B18ME6032	Experimental Stress Analysis		----	3	0	0	0	3	3	ME
	B18ME6033	Statistical Quality Control		----	3	0	0	0	3	3	ME
	B18ME6034	Plant Layout and Material Handling		----	3	0	0	0	3	3	ME
	B18ME6035	Artificial Intelligence		----	3	0	0	0	3	3	C&IT
4		**Soft Core -6**									
	B18ME6041	Automotive Engineering	SC	----	3	0	0	0	3	3	ME
	B18ME6042	Fracture Mechanics		18ME3020	3	0	0	0	3	3	ME
	B18ME6043	Mechatronics and Microprocessor		18ME1030	3	0	0	0	3	3	ME
	B18ME6044	Industrial Engineering		----	3	0	0	0	3	3	ME
	B18ME6045	Flexible Manufacturing System		----	3	0	0	0	3	3	ME
		Group-A									
5	B18ME6150	Dynamics of Machines	HC	18ME2050	3	1	0	0	4	5	ME
6	B18ME6160	Metal Forming Process	HC	----	3	0	0	0	3	3	ME
7	B18ME6170	Internal Combustion Engines Lab	HC	18ME4030	0	0	2	0	2	3	ME
8	B18ME6180	Design and Dynamics Lab	HC	----	0	0	2	0	2	3	ME
		Group-B									
5	B18ME6250	Heat Transfer	HC	18ME3030/4030	3	1	0	0	4	5	ME
6	B18ME6260	CAD/CAM/CIM	HC	----	3	0	0	0	3	3	ME
7	B18ME6270	Heat Transfer Lab	HC	----	0	0	2	0	2	3	ME
8	B18ME6280	CIM and Automation Lab	HC	----	0	0	2	0	2	3	ME
9	B18ME6090	Placement Training-4	FC		*0*	*0*	*2*	*0*	*2*	3	Placement
TOTAL CREDITS & CONTACT HOURS									**26**	**33**	
TOTAL CREDITS OF I SEMESTER TO VI SEMESTER									**150**		

Note: Those who studied Group A courses in V sem must study Group B courses in VI semester; Those who studied Group B courses in V sem must study Group A courses in VI semester

VII SEMESTER

Sl. No	Course Code	Title of the Course	Type of Course	Pre requisite	Credit Pattern & Credit Value					Contact Hours	Teaching School
					L	T	P	J	Total		
1	B18ME7010	Finite Element Methods	HC	18ME3020	2	1	0	0	3	4	ME
2	B18ME7020	Control Engineering*	HC	18ME2010	3	0	1	0	4	5	ME
3	B18ME7030	Engineering Economics and Financial Management	HC	----	4	0	0	0	4	4	ME
4	**Soft Core – 7**										
	B18ME7041	Cryogenic Engineering	SC	18ME4030	3	0	0	0	3	3	ME
	B18ME7042	Tribology and Bearing Design		18ME3020	3	0	0	0	3	3	ME
	B18ME7043	Automation in Manufacturing		----	3	0	0	0	3	3	ME
	B18ME7044	Non Destructive Testing		----	3	0	0	0	3	3	ME
	B18ME7045	Safety Engineering		----	3	0	0	0	3	3	ME
5	**Soft Core – 8**										
	B18ME7051	Computational Fluid Dynamics	SC	18ME3040	2	1	0	0	3	4	ME
	B18ME7052	Mechanical Vibrations		18ME5150	2	1	0	0	3	4	ME
	B18ME7053	Operation Research		----	2	1	0	0	3	4	ME
	B18ME7054	Gas Turbines and Jet Propulsion		18ME4030	2	1	0	0	3	4	ME
	B18ME7055	Data Analytics using R-Programming		----	2	0	1	0	3	4	C&IT
6	**Open Elective for other Schools**										
	B18ME7061	Project Management	OE	----	4	0	0	0	4	4	ME
	B18ME7062	Automobile Engineering			4	0	0	0	4	4	ME
7	B18ME7070	Structural Analysis Lab	HC	----	0	0	2	0	2	3	ME
8	B18ME7080	Product Design and Concept Lab	HC	----	0	0	0	2	2	3	ME
TOTAL CREDITS & CONTACT HOURS									**25**	**30**	
TOTAL CREDITS OF I SEMESTER TO VII SEMESTER									**175**		

Note: 1. Control Engineering Course is integrated with MAT Lab for practice session.

VIII SEMESTER

Sl. No	Course Code	Title of the Course	Type of Course	Pre requisite	Credit Pattern & Credit Value					Contact Hours	Teaching School
					L	T	P	J	Total		
1	**Soft Core – 9**										
	B18ME8011	Electric Vehicles and Hybrid Vehicles	SC	----	3	0	0	0	3	3	ME
	B18ME8012	Advanced Foundry Technology		----	3	0	0	0	3	3	ME
	B18ME8013	Additive Manufacturing		----	3	0	0	0	3	3	ME
	B18ME8014	New Venture Planning and Management		----	3	0	0	0	3	3	ME
	B18ME8015	Project Management		----	3	0	0	0	3	3	ME
2	**Soft Core – 10**										
	B18ME8021	Energy Audit and Management	SC		3	0	0	0	3	3	ME
	B18ME8022	Advanced Machine Design		18ME5010/6010	3	0	0	0	3	3	ME
	B18ME8023	MEMS		----	3	0	0	0	3	3	ME
	B18ME8024	Total Quality Management		----	3	0	0	0	3	3	ME
	B18ME8025	Internship		----	0	0	3	0	3	21days	--
3	B18ME8030	Project Work	SC	---	0	0	8	0	8	----	ME
4	B18ME8040	MOOC/Swayam/NPTEL *	SC	---	3	0	0	0	3	----	---
TOTAL CREDITS & CONTACT HOURS									**17**	**06**	
TOTAL CREDITS OF I SEMESTER TO VIII SEMESTER									**192**		

1. **Student should do 21 days one internship or 15 days each 2 internship or they have to study the soft core -10**
2. **Each student has to undergo Certification Programme through MOOC or NPTEL etc,.**

Detailed Syllabus
(Effective from 2018-19)

FIRST SEMESTER

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
B18ME1010	**Calculus**	HC	2	1	0	3	4
Prerequisites: Knowledge of limits, continuity, differentiation, integration, matrices, determinants, and geometry.		Internal Assessment			Semester End Exam		
		40 Marks			60 Marks		

Course Objectives:

1. Study the concept of polar coordinate system and its application to engineering problems.
2. To discover the concepts of differential calculus and its application.
3. To review partial differentiation and its application in various field.
4. Describe to solve analytically the first order first degree differential equation.
5. Study the concept of integration of functions of two/three variables over a region.
6. Defend to integrate improper integrals using Beta and Gamma function

Course Outcomes:
By the end of the course student shall be able to

1. Estimate the angle between polar curves; express the polar curve in terms of pedal form.
2. Determine radius of curvature and able to determine limits of indeterminate function applicable to already word problems and engineering problems.
3. Interpret partial differentiation to find the derivatives of implicit and composite functions.
4. Compute functional dependence using Jacobians. Learn to expand any functions of two variables in ascending power and to find the extreme value of a given function related to engineering problems and gain knowledge to solve differential equation arising in different engineering branch
5. Determine and solve first order ordinary differential equation
6. Elaborate the evaluation policy of some special functions like beta and gamma functions and their relation which is helpful to evaluate some definite integral arising in various branch of engineering.

Course Content:

UNIT-I: Calculus-I [11hrs]
Successive differentiation-nth derivatives (no proof and simple problems), Leibnitz Theorem (without proof) and problems, Taylor's series and Maclaurins series expansion for one variable (only problems), Polar curves- Angle between the radius vector tangent, angle between two curves, Pedal equation for polar curves.

UNIT-II: Calculus-II [11hrs]
Derivative of arc length – concept and formulae without proof, Radius of curvature-Cartesian, parametric, polar and pedal forms (without proof) problems. Indeterminate forms and solution using L'Hospital's rule.
Partial Differentiation: Partial derivatives-Euler's theorem-problems, Total derivative and chain rule

UNIT-III: Calculus-III **[11hrs]**

Jacobians-definition and problems (only find J and*reference- one example on $JJ^{/}$=1). Taylor's Expansion of function of two variables(only problems- up to 2nd order).Maxima and Minima for a function of two variables (simple problems). Curves in space, tangents and normal, Velocity and acceleration related problems, scalar and vector point functions-Gradient, Divergence and curl, directional derivatives. Solenoidal and irrotational vector fields, Vector identities-div ($\emptyset A$), curl ($\emptyset A$), curl (grad $\emptyset$), div (curl A).

UNIT-IV: Integral Calculus **[12hrs]**

Reduction formulae for the integrals of $\sin^n x$, $\cos^n x$, $\sin^m x \cos^n x$, and evaluation of these integrals with standard limits (direct result) - Problems.Multiple Integrals – Double integrals, change of order of integration (simple problems), and triple integrals. Beta and Gamma functions (definition),(properties and duplication formula -without proof), Relation between beta and gamma functions and simple problems.

Text books:

1. B.S. Grewal, "**Higher Engineering Mathematics**", Khanna Publishers, 43nd edition, 2015.
2. Erwin Kreyszig, "**Advanced Engineering Mathematics**", Wiley Publications, 9th edition, 2013.

Reference Books:

1. B.V. Ramana, "**Higher Engineering Mathematics**", Tata McGraw Hill Publications, 19th Reprint edition, 2013.
2. R.K.Jain and S.R.K.Iyengar, "**Advanced Engineering Mathematics**", Narosa Publishing House, 4th edition, 2016.

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
B18ME1020	**Applied Chemistry**	HC	3	0	0	3	3
Prerequisites: 10+2 Chemistry		Internal Assessment		Semester End Exam			
		40 Marks		60 Marks			

Course Objectives:

1. The Engineering Chemistry course for undergraduate students is framed to extend the fundamentals of chemistry and then build an interface of theoretical concepts with their industrial/engineering applications.
2. The course aim is to impart in-depth knowledge of the subject and highlight the role of chemistry in the field of engineering.
3. The lucid explanation of the topics will help students to apply the fundamental concepts in the innovation of new engineering materilas and solve problems related to them.
4. The extension of fundamentals of electrochemistry would assist in bringing innovation thrust in the field of energy storage devices.

Course Outcomes:

By the end of the course student shall be able to

1. The concepts of chemistry with respect to Electrochemical cells, fuel cells, mechanism of corrosion inculcate confidence in students to examine practical aspects for furtherance.

2. Acquire knowledge on industrially significant advanced engineering materials.
3. Differentiate materials to make it most suitably to an application.
4. Ascertain material selection for different engineering applications

Course Content:

UNIT-1 Mechanics in Atoms and Molecules, Principles of Thermodynamics [11 hrs]

Classical to quantum mechanical transition, Origin of quantum mechanics, dual nature of light and matter, concept of quantization – Max Planck, Einstein, de Broglie concepts, Schrödinger wave equation and wave functions, particle in a box (1D) - Energy solutions, quantum states of electron, quantum numbers, Orbital degeneracy, magnetic behaviour of matter, wave functions in bonding in molecules (H_2).

Thermal processes, introduction to thermodynamic laws, Internal energy change, enthalpy change (self-study) entropy change, Carnot cycle, Gibbs free energy changes, Free energy and EMF, Use of free energy considerations in metallurgy through Ellingham diagrams.

UNIT-2 Batteries and Fuel Cells [11 hrs]

Battery: Introduction to electrochemistry, Basic concepts of Cells and Battery, Battery characteristics – primary (Leclanche Cell), secondary (Lead-Acid), Lithium batteries, Advantage of use of Li as electrode material (Lithium & Lithium ion).Self-study – Reserve Battery, Capacitor & Super Capacitor.

Fuel Cells-Difference between battery and fuel cell, types of fuel cells- construction working, applications, advantages & limitations of Solid oxide fuel cells and phosphoric acid fuel cell. Self-study – Alkaline Fuel Cell.

Photovoltaic Cell- Construction and working of photovoltaic cells and its applications and advantages using elemental Si and semiconductors, antireflective coatings.

Self-study – Production of single crystal semiconductor by Crystal pulling technique (Czocharlski method), zone refining of Si.

Fuels – Classification, Characteristics of Fuels- Calorific Value (NCV & HCV) – Determination of CV by Bomb & Boy's Calorimeter, Units, Numerical Problems on NCV & GCV. Introduction to solid fuels, Liquid Fuels: Petroleum: Refining of Petroleum, Gasoline: Octane and cetane number, Synthetic **Petrol**: Bergius Processes and Fischer Troph's synthesis. Introduction to gaseous fuels.

Self-study – Combustion: reaction of combustion and related problems.

UNIT- 3 Science of Corrosion and Water Technology [11 hrs]

Electrochemical theory of corrosion, Types of Corrosion- Differential metal corrosion, Pitting corrosion, Boiler corrosion, Factors affecting rate of corrosion-Primary, secondary, Energy concept (Pourbiax) under different pH conditions. Corrosion Studies on Al, Fe with phase diagram.

Corrosion control: Cathodic protection, Anodic Protection.

Metal Finishing- Theory of electroplating. Effect of plating variables on the nature of electro deposit-electroplating process, Electroplating of gold. Electro less plating of Copper**.** Self-study**:** Galvanizing & tinning, organic and inorganic coatings

Water Technology: Introduction, impurities in water, boiler troubles - scale and sludge formation, priming and foaming- disadvantages & prevention methods. External treatment of boiler feed water – Lime Soda process, Zeolite process.

Self-study**:** Determination of COD and BOD of water, hardness of water, Ion exchange process

UNIT -4 Engineering Materials and Their Applications [12 hrs]

Lubricants-Introduction, Classification of lubricants (solid, semisolid, liquid and emulsion lubricants with examples). Lubricants for extreme ambient conditions and for special applications. Properties & selection

of lubricants (Specific and API gravity, oxidation, corrosion). Testing of lubricants and techniques (Viscosity by redwood viscometer and viscosity index, Flash and fire point test).

Polymers-Introduction, Types of polymerization - Addition and Condensation (two example; Polyester and Teflon). Glass transition temperature (t_g) - definition, significance. Structure and Property relationship – tensile strength and plastic and elastic deformation. Polymer composites (carbon fiber and Kevlar, synthesis, advantages, applications). Self – Study**:** Biocompatible materials

Nano Materials-Introduction – Definition, classification based on dimensionality (1D, 2D and 3D), quantum confinement (electron confinement). Size dependent properties- surface area, magnetic properties (GMR phenomenon) and thermal properties (melting point) and Mechanical properties. Properties of Carbon Nanomaterials (mention of -Fullerenes, Graphene, Carbon nanotubes). Applications of Nano materials- in hyperthermia (magnetic property), in corrosion control (Nano-coatings). Self – Study**:** Nano coatings for;Thermal management, Diamond Nano-coatings, thermal barrier and wear – resistant coatings.

Text Books

1. S S Dhara, **Engineering Chemistry** S. Chand Publications, New Delhi
2. Ashima Srivastava and N.N. Janhavi **Concepts of Engineering Chemistry**- Shashichawla, Dhanapathi rai Publications.
3. R.V.Gadag & Nithyanandashetty, "**Engineering Chemistry**", IK Interanational Publishing house.
4. V.R. Gowrikar, N.N. Vishwanathan and J. Sreedhar "**Polymer Chemistry**" Wiley eastern ltd.
5. M.G. Fontana, "**Corrosion Engineering**" Tata Mcgraw hill Publishing pvt. Ltd.
6. Charles P. Poole Jr., Frank J. Owens, "**Introduction to Nanotechnology**", Wiley India Publishers.
7. O.P. Vermani and Narulla, "**Theory and practice in applied chemistry**", New age international publications.
8. Krishan K Chawla **Composite materials – Science and Engineering**, Springer International edition, Second edition.
9. Charles P. Poole Jr., Frank J. Owens **Introduction to Nanotechnology** Wiley India Publishers.
10. V.R. Gowrikar, N.N. Vishwanathan and J. Sreedhar **Polymer Chemistry** Wiley eastern ltd.

Reference Books

1. Mars G. Fontana **Corrosion Engineering**, Tata Mcgrahill Publishing pvt. Ltd, Third edition.
2. G.H. Jeffery, J. Bassett, J. Mendham and R.C. Denney "**Vogel's text book of quantitative chemical analysis".**
3. Charles P. Poole Jr., Frank J. Owens I**ntroduction to Nanotechnology** Wiley India Publishers.
4. Jain and Jain **Engineering Chemistry**, Dhanapathi Rai Publications, New Delhi

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
B18ME1030	**Basic Electrical and Electronics Engineering**	HC	2	0	1	3	5
Prerequisites: Nil		Internal Assessment	Semester End Exam				
		40 Marks	60 Marks				

Course Objectives:

1. Explain concept of various types of generation of electricity.
2. Demonstrate basic representation of electrical quantities and relationship among them.

3. Infer an overview of various types of electrical apparatus.
4. Interpret the concept of domestic wiring and importance of safety and sensing devices.

Course Outcomes:

By the end of the course student shall be able to

1. Demonstrate the operation and control of various types of generation of electricity
2. Explain the principle of operation of electrical apparatus
3. Differentiate between single and three phase systems,
4. Determine simple mathematical relationships related to electrical apparatus.
5. Interpret the applications of electronic devices and sensors in practical life.
6. Demonstrate how to work safely with electrical equipment and also to illustrate appropriate safety gadgets to avoid accidents.

Course Content:

Unit -1: Electrical Circuits [11hrs]

Basic definitions, Types of elements, Ohm's Law, Kirchhoff's Laws, Resistive, Inductive, capacitive networks, Series, Parallel circuits and Star-delta and delta-star transformations, Generation of an alternating Emf – average and rms values of alternating quantity – representation of alternating quantities by phasors – single phase series and parallel circuits (simple problems), three phase systems and power calculations.

Unit- 2: Machines [11hrs]

Construction and Principle of operation of DC Machines–Emf & Speed equations - types –applications. AC MACHINES: Principle of operation of single phase transformers – Emf equation – losses – efficiency and regulation-Construction and working principle of induction motors –Slip–torque characteristics– applications-Construction and Principle of operation of alternators-applications. Different types of starters for AC & DC motors.

Unit- 3: Instruments [11hrs]

Basic Principle of indicating instruments –PMMC & MI instruments. TARIFF, PROTECTIVE DEVICES AND SENSORS: Tariff schemes, basic concepts of domestic wiring and types, Earthing, protective fuses, MCB, sensors: pressure sensors, strain gage, proximity sensors, displacement sensors, totary encoder and ultrasonic sensors and civil engineering applications.

Unit-4: Semiconductor Diodes [12hrs]

Introduction, Physical operation of p-n junction diodes, Characteristics of p-n junction diodes, Zener diode, Rectifier circuits (half-wave, full-wave, bridge and peak rectifiers), Light emitting diodes.
DIGITAL **Electronic Principles:** Introduction, Binary digits, Logic levels and Digital waveforms, Introduction to basic logic operation, Number system, Decimal numbers, Binary numbers, Decimal-to-Binary conversion, Simple binary arithmetic

Labs sessions for 2 hours/week

1. Electrical tool introduction
   (i) Electrical Tools
   (ii)Measuring Instruments like Ammeter, Voltmeter, Multimeter, Clamp on meter, Energy meter, Watt meter (UPF & LPF)
2. Home electrical wiring demonstration:
   (i) Tube light wiring
   (ii) Fan wiring

(iii) Two way control
(iv) Socket to switch connection.
(v) Electrical wiring materials & accessories

3. Study of mutual induction effect.
4. Electrical safety training:
   (i) Electrical activities to avoid shocks and importance of earthing
   (ii)Working of MCB, ELCB
   (iii) Role of fuse.
5. Home electrical wiring demonstration: short circuit, series and parallel operation of load.
6. Single phase transformer: polarity tests.
7. Diode rectifier applications: Half wave and Full wave rectifier, ripple factor calculations.
8. Sensor experiments: Pressure sensor, light sensor and temperature sensor.

Text Books :

1. David V. Kerns, JR. J. David Irwin **Essentials of Electrical and Computer Engineering** Pearson.
2. V.K.Mehta **Principles of Electrical and Electronics Engineering**, S.Chand & Co. 48
3. Robert L. Boylestad and Louis Nashelsky, **Electronic Devices and Circuit Theory** (Ninth Edition), Pearson Education, 482 FIE, Patparganj, Delhi – 110 092.
4. Thomas L. Floyd and R.P. Jain **Digital Fundamentals** (Eighth Edition), Pearson Education

Reference Books:

1. M.S Naidu and S. Kamakshaiah **Introduction to Electrical Engineering** –, TMH Publ.
2. Kothari and Nagarath **Basic Electrical Engineering**, TMH Publications, 2nd Edition.
3. Theodore Wildi, "**Electrical Machines, Drives, and Power Systems**", Pearson Education, 5th Edition, 2007

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
B18ME1040	**Computer Aided Engineering Drawing**	HC	1	0	2	3	5

Prerequisites: Basic Knowledge on geometry and their construction	Internal Assessment	Semester End Exam
	40 Marks	60 Marks

Course Objectives:

1 Explain general projection theory, with emphasis on orthographic projection to represent in two-dimensional views.
2 Dimension and annotate two-dimensional engineering drawings.
3 Review the application of industry standards and best practices applied in engineering graphics.
4 Demonstrate freehand sketching to aid in the visualization process and to efficiently communicate ideas graphically.
5. The theoretical concepts delivered in this course would help the students to explore the sign considerations and tolerances to be used in the design and manufacture of engineering components.

Course Outcomes:

By the end of the course student shall be able to

1. Demonstrate independent thinking and problem solving capabilities
2. Express component descriptions as per the commonly practiced standards

3. Explain the difference of 2D and simple 3D drawings
4. Review industry specific drawings
5. Classify through computer aided drawing any Objects/tools/instruments /elements/ structures belonging to the entire engineering field
6. Explore simple clear and illustrative drawings as per existing standards conversations.

Course Content:

UNIT-1 Introduction to Drawing and Orthographic projection of Points, Lines and Plane Surface. [11Hrs]

Introduction to Drawing: Introduction, Drawing Instruments and their uses, BIS conventions, Drawing sheets, Dimensioning, regular polygons and their construction and brief introduction to solid edge software.

Projection of Points: Points in different quadrants.

Projection of Straight Lines (First-angle Projection only): Parallel to one or both planes – Perpendicular to one plane and parallel to other plane, Inclined to one plane and parallel to the other, Inclined to both planes.

Projection of Plane Surface: Types of Planes, Projection of Planes, perpendicular to VP and inclined to HP – Inclined to both the planes.

UNIT-2 Projection of Solids [11Hrs]

Square, pentagonal and hexagonal prisms and pyramids, cone and cylinder, Solids in simple position, Axis of the solid parallel to one plane and inclined to other plane, axis of the solid inclined to both the plane. Use change of position method and auxiliary plane method.

UNIT -3 Section of Solids and Developments of Lateral Surfaces of Solids [11Hrs]

Section Planes, Sections ,True Shape of Section, Sections of Prisms, Sections of Pyramids, Sections of Cylinders, Section of Cones.

Developments of Lateral Surfaces of Solids: Prisms and Pyramids, Cone, Cylinder, Frustum of cone and pyramids, truncated cone and pyramids

UNIT - 4 Isometric Projection [12Hrs]

Isometric axes, Lines and Planes, Isometric Scale, Isometric Projection of Planes, Cube, Prisms, Pyramids, Cylinders, Cone and Sphere, Combination of Solids.

Text Books:

1. K S Narayanswamy and Prof.Mahesh L **Text Book on Engineering Drawing,** WILEY Publishers 2017, ISBN: 978-81-265-7004-1.
2. N.D.Bhatt and V.M. Panchal **Engineering Drawing** , 48th Edition, 2005 – Charotar Publishing House, Gujarat.
3. K.R. Gopalakrishna, **Engineering Graphics** - 32nd Edition, 2005 – Subhas Publishers, Bangalore.

Reference Books:

1. P. S. Gill, **Engineering Drawing**, 11th Edition, 2001 – S. K. Kataria& Sons, Delhi.

Course Code	Course Title	Course Type	L	T	P	C	Hrs. / Wk.
B18ME1050	**Environmental Studies**	FC	2	0	0	2	2
Prerequisites: Chemistry		Internal Assessment		Semester End Exam			
		40 Marks		60 Marks			

Course Objectives:

1. Graduates will be familiar with current and emerging environmental engineering and global issues, and explore ethical and social responsibilities.
2. Graduates will ascertain the ability to obtain the knowledge, and will recognize the need for engaging in life-long learning.
3. Will find the need of various types of energy (conventional & non-conventional) resources and natural resources.
4. Explore knowledge with respect to biodiversity, threats, conservation and appreciate the concept of ecosystem.
5. Examine knowledge about environmental pollution-sources, effects and control measures of environmental pollution, degradation and waste management.
6. Explore the ways for protecting the environment.

Course Outcomes:

By the end of the course student shall be able to

1. Analyze the environmental conditions and protect it.
2. Will interpret the role of individual, government and NGO in environmental protection.
3. Examine new renewable energy resources with high efficiency through active research.
4. Analyze the ecological imbalances and protect it.
5. Discover the causes of environmental pollution & find ways to overcome them.
6. Design pollution controlled products.

Course Content:

UNIT -1 Multidisciplinary Nature of Environmental Studies [11Hrs]

Environment, objectives and guiding principles of environmental education, Components of environment, Structure of atmosphere, Sustainable environment/Development, Impact of technology on the environment in terms of modern agricultural practices and industrialization, Environmental Impact Assessment. Environmental protection – Role of Government-Assignments of MOEF, Functions of central and state boards, Initiative and Role of Non-government organizations in India and world.

Self-study**:** Need for public awareness on the environment, Gaia Hypothesis.

UNIT-2 Environmental Pollution, Degradation and Waste Management [11 Hrs]

Environmental Pollution – Definition, sources and types, Pollutant-Definition & classification, Concepts of air pollution, water pollution, Soil pollution, Automobile pollution-Causes, Effects & control measures.

Self-study**:** Case studies of London smog, Bhopal gas tragedy, marine pollutions and study of different waste water treatment processes.

Environmental Degradation – Introduction, Global warming and greenhouse effect, acid rain-formation & effects, Ozone depletion in stratosphere and its effect. Solid Waste management – Municipal solid waste, Biomedical waste, Industrial solid waste and Electronic waste (E-Waste).

Self-study**:** Disaster management, early warning systems-bio indicators for Tsunami and other natural disasters.

UNIT-3 Energy and Natural Resources [11Hrs]

Energy – Definition, classification of energy resources, electromagnetic radiation-features and applications, Conventional/Non-renewable sources – Fossil fuels based(Coal, petroleum & natural gas), nuclear energy, Non-conventional/renewable sources – Solar, wind, hydro, biogas, biomass, geothermal, ocean thermal energy, Hydrogen as an alternative as a future source of energy.

Self-study: Remote sensing and its applications, Chernobyl (USSR) nuclear disaster and Fukushima (Japan) nuclear disaster.

Natural resources –water resource(Global water resource distribution, Water conservation methods, Water quality parameters, Uses of water and its importance), Mineral resources (Types of minerals, Methods of mining & impacts of mining activities),Forest wealth (Importance, Deforestation-Causes, effects and controlling measures)

Self-study: Hydrology & modern methods adopted for mining activities.

UNIT-4 Ecology and Ecosystem [12Hrs]

Ecology-Definition, branches, objectives and classification, Concept of an ecosystem – Structure and functions, Characteristics of an Ecosystem-Ecosystem Resilience, Ecological succession and productivity, Balanced ecosystem, Components of ecosystem-abiotic and biotic, biological diversity.

Biogeochemical cycles and its environmental significance – Carbon and nitrogen cycle, Energy flow in ecosystem, food chains –types, food web & Ecological Pyramids.

Self-study: Need for balanced ecosystem and restoration of degraded ecosystems.

Text Books:

1. R.J. Ranjit Daniels and Jagadish Krishna swamy **"Environmental Studies**", , (2017), Wiley India Private Ltd., New Delhi, Co-authored & Customised by Dr.MS Reddy & Chandrashekar, REVA University.
2. R.J. Ranjit Daniels and Jagadish Krishnaswamy "**Environmental Studies**", , (2009), Wiley India Private Ltd., New Delhi.
3. Benny Joseph, "**Environmental Studies**" Tata McGraw – Hill Publishing Company Limited.
4. Dr.S.M.Prakash, **Environmental Studies** by Elite Publishers Mangalore, 2007

Reference Books:

1. Rajagopalan R. 2005,"**Environmental Studies – from Crisis to cure**", Oxford University Press
2. Arvindwalia, Kalyani **Environmental Science** Publications, 2009.
3. Anilkumar Dey and Arnabkumar Dey **Environmental Studies**.

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
B18ME1060	Technical English-I	FC	0	0	2	2	4

Prerequisites: Basic English	Internal Assessment	Semester End Exam
	40 Marks	60 Marks

Course Objectives:

1. To explore basic communication skills in English for the learners of Engineering and Technology.
2. To prioritize listening and reading skills among learners of Engineering and Technology.
3. To extend writing skills needed for academic as well as workplace context.
4. To examine that the learners use the electronic media such as internet and supplement the learning materials used in the classroom

Course Outcomes:

By the end of the course student shall be able to

1. Interpret audio files and comprehend different spoken discourses/ excerpts in different accents (Listening Skills).
2. Demonstrate speaking ability with clarity, confidence and comprehension and communicate with one or many listeners using appropriate communicative strategies (Speaking Skills).
3. Review the use of reading different genres of texts adopting various reading strategies (Reading Skills).
4. Determine the ability to write cohesively, coherently and flawlessly avoiding grammatical errors, using a wide vocabulary range, organizing their ideas logically on a topic (Writing Skills).

Course Content:

UNIT-1 Functional English [14 hrs]

Speaking: Debating Skills, **Reading:** Skimming a reading passage; Scanning for specific information, **Writing:** Email communication.

UNIT- 2 Interpersonal Skills [14 hrs]

Grammar: Tenses; Wh-questions, **Listening& Speaking:** Listening and responding to video lectures / talks, **Reading:** Reading Comprehension; Critical Reading; Finding key information in a given text, **Writing:** Process descriptions (general/specific); Recommendations

UNIT-3 Multitasking Skills [14hrs]

Grammar: Conditional Sentences, **Listening & Speaking:** Listening to specific task; focused audio tracks and responding, **Reading:** Reading and interpreting visual material, **Writing:** Channel conversion (flowchart into process); Types of paragraph (cause and effect / compare and contrast / narrative / analytical); Note Taking/ Note Making

UNIT- 4 Communication Skills [14 hrs]

Grammar: Direct and indirect speech,
Listening & Speaking: Watching videos /documentaries and responding to questions based on them; Role plays,
Reading: Making inference from the reading passage; predicting the content of a reading passage,
Writing: Interpreting visual materials (line graphs, pie charts etc.); Different types of Essay Writing

Text Books

1. Green, David. Contemporary English Grammar Structures and Composition. New Delhi: MacMillan Publishers, 2010.
2. Thorpe, Edgar and Showick Thorpe. Basic Vocabulary. Pearson Education India, 2012.
3. Leech, Geoffrey and Jan Svartvik. A Communicative Grammar of English. Longman, 2003.
4. Murphy, Raymond. Murphy's English Grammar with CD. Cambridge University Press, 2004.

References

1. Rizvi, M. Ashraf. Effective Technical Communication. New Delhi: Tata McGraw-Hill, 2005
2. Riordan, Daniel. Technical Communication. New Delhi: Cengage Publications, 2011.
3. Sen et al. Communication and Language Skills. Cambridge University Press, 2015.

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
B18ME1070	**Applied Chemistry Lab**	HC	0	0	2	2	3
Prerequisites: 10+2 Chemistry knowledge		Internal Assessment		Semester End Exam			
		20 Marks		30 Marks			

Course Objectives:

1. Explore practical aspects of the redox reaction.
2. Explain the function of fuel cells, batteries and extend the knowledge to the processes of corrosion and its prevention.
3. Interpret preparation and properties of synthetic polymers and other material that would provide sufficient impetus to engineer these to suit diverse applications.
4. Examine the hygiene aspects of water and design methods to produce potable water using modern technology.

Course Outcomes:

By the end of the course student shall be able to

1. Demonstrate the use of different types of instruments for analysis of materials for better accuracy and precision
2. Interpolate different types of titrations for quantitative estimations of materials.

List of Experiments:

1. Potentiometric estimation of FAS using standard $K_2Cr_2O_7$
2. Conductometric estimation of an acid mixture using standard NaOH solution
3. Determination of pKa of a weak acid using pH meter

4. Determination of molecular weight of given polymer sample using Ostwald's Viscometer
5. Determination of COD of the given industrial waste water sample
6. Determination of total and temporary hardness of water using disodium salt of EDTA
7. Estimation of alkalinity of given water sample using standard HCl solution.
8. Determination of calcium oxide in the given sample of cement by rapid EDTA method
9. Determination of flash and fire point of petroleum products by Cleveland (open cup) apparatus.
10. Determination of flash point of oils by Pensky Martins flash point apparatus.
11. Determination of viscosity of the given oil using Redwood Viscometer at different temperatures.
12. Determination of viscosity of the given oil using Say Bolt Viscometer at different temperatures.
13. Determination of viscosity of the given oil using Torsion Viscometer at different temperatures.
14. Determination of the calorific value of gaseous fuel by Boy's gas calorimeter

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
B18ME1080	**Workshop Practice**	HC	0	0	2	2	3

Prerequisites: Mechanical Engineering Science	Internal Assessment	Semester End Exam
	20 Marks	30 Marks

Course Objectives:

1. To elaborate knowledge and skill to use tools, machines, equipment, and measuring instruments.
2. To demonstrate safe handling of machines and tools.
3. To gain the knowledge of automobile parts

Course Outcomes:

By the end of the course student shall be able to

1. Identify the various fitting tools
2. Demonstrate and produce different types of fitting models.
3. Make simple sheet metal models and apply the skill in real.

Course Content:

1. Use of Hand Tools: V-block, Marking Gauge, Files, Hack Saw, Drills, Taps and Minimum 3 models involving Dove tail joint, Triangular joint and Semicircular joint.
2. Sheet Metal & Soldering Work: Development & Soldering of the models: Tray, Frustum of cone, Prism(Hexagon & Pentagon),Truncated Square Pyramid, Funnel
3. Welding: Study of electric arc welding tools & equipment's, Demonstration of Welding.
   Study the assembly and disassembly of the automobile engine.

Text Books: Workshop Manual Prepared by REVA University Staff

SECOND SEMESTER

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
B18ME2010	Linear Algebra and Laplace Transform	HC	2	1	0	3	4

Prerequisites: Knowledge of basics of derivatives, vectors, complex numbers	Internal Assessment	Semester End Exam
	40 Marks	60 Marks

Course Objectives:

1. Explore the concepts of Linear algebra and its applications in various fields of engineering and Technology.
2. Explain the concepts of Integral calculus and its applications.
3. Interpret partial differential equations, and its applications to standard problems like Heat, Wave and Laplace.
4. Infer the Knowledge of Laplace transforms and its applications in the field of engineering.

Course Outcomes:

By the end of the course student shall be able to

1. Interpret the knowledge of Linear Algebra in Image processing and digital signal processing.
2. Explain analytical techniques to compute solutions of first and higher order ordinary differential equations.
3. Examine the knowledge of partial differential equations in the field of signals and systems, control systems, magnetic wave theory.
4. Customize the knowledge of Laplace transformation from the time domain to the frequency domain, which transforms differential equations into algebraic equations and convolution into multiplication.
5. Determine tangential and normal component of a vector, identify solenoid and irrotational vectors and solve problems using vector identities.
6. Examine the interdependence of line, surface and volume integrals using integral theorems

Course Content:

UNIT-1: Linear Algebra [11hrs]

Rank of matrix, Echelon form, (*reference-Normal form: one example), Solution of a system of linear equations by Gauss elimination (*reference-Gauss –Jordan methods: one example), Gauss seidel iterative method, Rayleigh Power method to find the largest Eigen value and corresponding Eigen vector.LU decomposition, Linear and Inverse transformation. Diagosnalisation of a matrix, Reduction of a quadratic form to canonical form by orthogonal transformation.

UNIT-2: Differential Equations [11hrs]

Differential Equations of Ist order and Ist degree: Exact equation and reducible to exact form(1. Close to expression M or N and find IF, 2. Y f(x) dx+x g(y) dy).

Linear Differential Equations: Definitions, Complete solution, Operator D, Rules for finding the complementary function, Inverse operator, Rules for finding the particular integral.Method of variation of parameters (simple problems), Cauchy's and Legendre's linear differential equations.

Partial differential equations: Formation of Partial differential equations, Solution of Lagranges linear PDE.

UNIT-3: Laplace Transforms [11hrs]

Laplace Transforms of elementary functions, properties of Laplace Transforms, Laplace Transforms of derivatives and integrals, problems. Transforms of periodic functions, Unit step functions and unit impulse functions.

UNIT-4: Inverse Laplace Transforms [12hrs]

Inverse Laplace transform of standard functions, different methods of solving inverse Laplace transforms convolution theorem, verification and problems, solution of linear differential equation using Laplace transforms.

Text books:

1 B.S. Grewal, "**Higher Engineering Mathematics**", Khanna Publishers, 43nd edition, 2015.
2 Erwin Kreyszig, "**Advanced Engineering Mathematics**", Wiley Publications, 9th edition,2013.

Reference Books:

1 B.V. Ramana, "**Higher Engineering Mathematics**", Tata McGraw Hill Publications, 19th Reprint edition, 2013.
3. R.K.Jain and S.R.K.Iyengar, "**Advanced Engineering Mathematics"**, Narosa Publishing House, 4th edition, 2014.

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
B18ME2020	**Applied Physics**	HC	3	0	0	3	3
Prerequisites: 10+2 Physics		Internal Assessment		Semester End Exam			
		40 Marks		60 Marks			

Course Objectives:

1. To introduce the basic concepts and principles of Physics to analyze practical engineering problems and apply its solutions effectively and efficiently.
2. To be acquainted with the basic concepts of properties of fluids, pressure and its measurements
3. To impart the different physical phenomena in fluid mechanics and materials science.
4. To develop design, practical oriented skills and problem solving challenges.
5. To incorporate the knowledge in various class of materials and their applications

Course Outcomes:

By the end of the course student shall be able to

1. Apply concept of Physics to explain and analyze various physical phenomena used in wide range of engineering applications.
2. Apply the knowledge of fluid mechanics and its applications in real life problems.
3. Analyze the material selection for different applications.
4. Design the hydraulic structures.
5. Demonstrate different applications of pressure measuring gauges.
6. Recognize the need for measurement and calibration

Course Content:

UNIT-1 Hydrostatics-I [11hrs]

Properties of Fluids: Physical properties of fluids like Density, Specific Weight, Specific Gravity, Specific Volume, Surface Tension, Capillarity, Viscosity, Compressibility and Bulk Modulus, Classifications of Fluids.

Pressure and its measurements: Pressure, Pascal's law, pressure at a point, hydrostatic Law, atmospheric pressure, absolute pressure, gauge pressure and Vacuum pressure and Manometers.

UNIT- 2: Hydrostatics-II [11hrs]

Hydrostatics Forces on plane submerged surfaces, Forces on Horizontal surfaces, on Vertical Surfaces, on Inclined Surfaces, on Curved Surfaces. Buoyancy and Flotation, Archimedes' Principle, Stability of Immersed and floating bodies, determination of metacentric height.

UNIT - 3: Smart and Nano Materials [11hrs]

Materials exhibiting ferroelectric, piezoelectric, Optoelectric and semiconducting properties. Photo conductivity and super conductivity behavior (Examples with applications). Introduction to bio materials, super alloys and shape memory alloys.

Nano materials: Introduction to Nano science, Nano materials. Synthesis of nanomaterial's using bottom up method (Arc Method), Top Down method (ball milling method), properties and applications of carbon Nano tubes.

UNIT- 4: Measurement and Measurement Systems [12 hrs]

Introduction, Definition, Requirement of measurements, significance of measurement system, generalized measurement system, definitions and concept of accuracy, precision, calibration, threshold, sensitivity, hysteresis, repeatability, linearity, loading effect, system response-times delay. Errors in measurement, classification of errors. Transducers, transfer efficiency, primary and secondary transducers. Mechanical members: Bourdon tube, Diaphragm, Bellows. Electrical members: Resistive, capacitive, piezoelectric and photoelectric transducers.

Intermediate Modifying and Terminating Devices: Introduction, Mechanical systems, inherent problems, electrical intermediate modifying devices, input circuitry, ballast circuit, electronic amplifiers, Vacuum tube amplifiers and telemetry. Introduction to Terminating devices, Meter indicators, CRO, Measurement of frequency, Oscillographs, X-Y plotters.

Text books:

1. Dr.R. K. Bansal **A Textbook of Fluid Mechanics and Hydraulic Machines** , Laxmi Publications ,New Delhi
2. William Smith, **Foundations of Materials Science and Engineering,** McGraw-Hill Science Engineering Math.
3. Beckwith Marangoni and Lienhard, **Mechanical Measurements**, Pearson Education, 6th Ed., 2006.
4. R.K. Jain **Mechanical Measurements**, Khanna Publishers, 1994.

Reference Books:

1. Dr. P. N. Modi & Dr.S.M.Seth, **Hydraulics and Fluid Mechanics**, Standard Book House.
2. Shackleford, & M. K Muralidhara, **Material science**, Pearson Publications, 2007.
3. Anand.K.Bewoor and VinayA Kulkarni **Mechanical Measurements and Metrology**, McGraw-Hill Science.

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
B18ME2030	"C" Programming	HC	3	0	0	3	3

Prerequisites: Basic Knowledge of computer	Internal Assessment	Semester End Exam
	40 Marks	60 Marks

Course Objectives:

1. Discuss the fundamentals of computer System.
2. Extend an understanding of problem solving with computers.
3. Interpret C programming language.
4. Provide a familiarization with the Unix programming environment;
5. Examine problem solving through authoring and executing C programs.

Course Outcome:

By the end of the course student shall be able to

1. Explore basic aspects of computer programming;
2. Explain the different Unix commands, their usage and their syntax;
3. Interpret, compile and debug programs in C language;
4. Demonstrate different data types and operators in a computer program;
5. Design programs involving decision structures, loops and functions;
6. Elaborate procedure calls by value and by reference;
7. Review arrays in applications like sorting and searching;
8. Demonstrate strings;
9. Infer C language knowledge to solve variety of problems

Course Content:

UNIT- 1: Introduction to Computer System [11hrs]

Introduction Definition of computer, structure of a computer, basics of computer hardware and software, types and functions of operating system.

Basic Commands in UNIX: Introduction to basic command format, using the vi text editor, Basic Unix commands, types of computer networks.

UNIT- 2: Fundamentals of Problem Solving and introduction to C-Language [11hrs]

Algorithm and flowchart & advantages of algorithm (pseudo code), Basic flow chart symbols, structure of c program with example, c language & its features, c tokens, data types in c ,variables, constants, input / output functions.

Operator: (unary operator, assignment operator, arithmetic operator, relational operator, logical operator, logical operator, bitwise types of operator's operator, conditional operator, increment and decrement operator, special operator).

Expressions & statements: Postfix, primary, prefix, unary, binary, ternary & assignment

Branching constructs.

Unconditional statements: break and continue statement, go to statement, return statement

UNIT- 3: Iterative Statements [11hrs]

Iterative statements (loops): While loop, do while, difference between while and do while for loop.

Arrays: one dimensional array, two dimensional array, searching techniques(binary search), sorting (bubble sort)

Functions, strings & pointers: function definition, types of function, location of function in a program, structure of a function, parameter passing mechanisms, call by value & call by address.

UNIT 4: Strings and Pointers [12hrs]

Strings: String operations with and without using inbuilt string functions (string length, string compare, string copy, string concatenation, string reverse)

Pointers: Introduction to pointers.

Fundamentals of computer graphics: Output primitives – Line, Circle and Ellipse Drawing algorithms – Attributes of output primitives, Two dimensional Geometric transformation

Text Books

1. Sumitabha das, **UNIX concepts and applications**, 4th edition; TataMcgraw hill.
2. B.S. Anami, S.A. Angadi and S. S. Manvi, **computer concepts and c programming: a holistic approach**, second edition, 2008.
3. Nanjeshbennur, Dr. C.K.Subbaraya, **Programming in C**, excellent publishing house, 2015.
4. Edward Angel, **Interactive Computer Graphics**, 6th Edition, Pearson.
5. Donald Hearn, Pauline Baker, Computer Graphics C Version, second edition, PearsonEducation, 2004.

References

1. Herbert Schildt, C: **The Complete Reference**, 4th edition, TATA MCGRAW Hill.
2. E. Balaguruswamy, **Programming in ANSI C**, 4th edition, TATA MCGRAW Hill, 2008.

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
B18ME2040	**Manufacturing Technology**	HC	3	0	0	3	3

Prerequisites: Nil	Internal Assessment	Semester End Exam
	40 Marks	60 Marks

Course Objectives:

1. To develop the basic knowledge of working of various metal casting process
2. To acquire knowledge in casting defects and melting practices in foundry.
3. Explain the concepts of metal joining process and their applications
4. Interpret appropriate production process for a specific application.
5. Develop the knowledge of special welding process and inspection methods.

Course Outcomes:

By the end of the course student shall be able to

1. Explain the concepts of working principle of metal joining process.
2. Identify the inspection methods based on the defects.
3. Describe the various casting process and can build his career in foundry.
4. Demonstrate the principles associated with special casting process.

Course Content:

UNIT – 1 Introduction to Foundry [11 hrs]

Introduction to Foundry – Concept of manufacturing process, classification of manufacturing process, Casting process and Steps involved in casting, advantages, limitations and applications of casting process. **Pattern**: Definition, different types of pattern, materials used for pattern, allowances for pattern and their importance. **Sand Moulding**: Types of Base sand, Requirements of base sand, Binder and additives used in moulding sand, Moulding sand mixture ingredients for different sand mixtures. **Cores**: Definition, Need and Types of cores. Concept of Gating and risers, Fettling and cleaning of castings, casting defects.

UNIT-2 Special Moulding Process [11 hrs]

Study of special Moulding processes: CO_2 mould, shell mould, investment mould.

Metal Moulds: Metallic moulds, Types of metallic mould castings: Gravity die castings, pressure die castings, Centrifugal castings, Slush castings, Squeeze castings, Thixo casting.

Melting Furnaces: Classification, constructional features and working principle of coke fired and Gas fired pit furnace, Resistance furnace, Electric arc furnace, Cupola furnace.

UNIT-3 Metal Joining Processes [11 hrs]

Welding Process: Definition, Principles, Classification, Application, Advantages & limitations of welding. Gas welding Principle, Oxy – Acetylene welding, Types of flame and Flame characteristics.

Electric Arc Welding: Introduction to Arc welding, Classification of Arc welding, FSMAW, TIG, MIG, Arc welding current and voltage, Arc welding equipment's.

Soldering and Brazing: Principles of soldering & brazing, Distinguish between soldering and brazing.

UNIT- 4: Advanced Welding Process and Inspection [12 hrs]

Special Welding: Resistance welding - principles, Seam welding, Butt welding, Spot welding and projection welding. Friction welding-Explosive welding, Thermit welding, Laser welding and Electron beam welding.

Inspection Methods – Methods used for Inspection of casting and welding-Visual, Magnetic particle, Fluorescent particle, Ultrasonic, Radiography, Eddy current, Holography methods of Inspection.

Text Books:

1. S. Kalpakjian and S.R. Schmid, "**Manufacturing Engineering and Technology**", 7 th Edition, Prentice-Hall, 2013
2. P.C. Sharma Production Technology (Manufacturing Processes), S. Chand.
3. O.P Khanna **"Production Technology (Manufacturing Processes-Vol-1**)" by, DhanpatRai Publications.
4. Dr.K.Radhakrishna "**Manufacturing Process-I**", Sapna Book House, 5th Revised Edition 2009.
5. P.N.Rao "**Manufacturing Technology: Foundry Forming and Welding**", 3rd Ed., Tata McGraw Hill, 2003.

Reference Books:

1. S.K. Hajra Choudhury (2001), **Elements of Workshop Technology, Vol-I**, Media Promoters Pvt Ltd., Mumbai.
2. P.N. Rao (1998), **Manufacturing Technology – Foundry, Forging and Welding**, Tata McGrawHill Publishing Co., New Delhi.
3. Roy A. Lindberg (2004), **Processes and Materials of Manufacture**, 4th Edition, Prentice-Hall of India, New Delhi.
4. Banga T.R; and Agrawal R.L, "**Foundry Engineering**", Khanna

Publishers, 1992.
5. Serope Kalpakjian, Steuen. R. Sechmid "**Manufacturing Technology**", Pearson Education Asia, 5th Ed. 2006

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
B18ME2050	**Engineering Mechanics**	HC	2	1	0	3	4

	Internal Assessment	Semester End Exam
Prerequisites: Basic Physics	40 Marks	60 Marks

Course Objectives:

1. Explain good materials that need to be used for the construction work
2. Demonstrate the basics of Civil Engineering concepts and infrastructure development.
3. Detail problems involving Forces, loads and Moments and know their applications in allied subjects.
4. Interpret the concepts in courses like Strength of materials, Design of Machine Elements, Kinematics and Dynamics of Machines.

Course Outcomes:

By the end of the course student shall be able to

1. Explore the basics of Civil Engineering with regard to its scope of study.
2. Comprehend the action of Forces, Moments and other loads on systems of rigid bodies.
3. Compute the reactive forces and the effects that develop as a result of the external loads.
4. Locate the Centroid and compute the Moment of Inertia of regular cross sections.

Course Content:

UNIT - 1: Introduction [11hrs]

Scope of Civil Engineering, Branches of Civil Engineering, Role of Civil Engineer's, Classification of Roads and their functions, Building Materials Stone as building material, Requirement of good building stones, Dressing of stones, Deterioration and Preservation of stone work. Bricks, Classification, Manufacturing of clay bricks, Requirement of good bricks, Cement Concrete blocks, Stabilized Mud Blocks, Sizes, requirement of good blocks.

Introduction to Engineering Mechanics:

Basic idealizations - Particle, Continuum and Rigid body, Force and its characteristics, types of forces, Classification of force systems; Principle of physical independence of forces, Principle of superposition of forces, Principle of transmissibility of forces; Newton's laws of motion, Introduction to SI Units, Moment of a force, couple, moment of a couple, characteristics of couple, Equivalent force - couple system, Resolution of forces, composition of forces; Numerical problems on moment of forces and couples and equivalent force - couple system.

UNIT -2 Analysis of Force Systems [11hrs]

Analysis of Force Systems: Composition of forces - Definition of Resultant, Composition of coplanar - concurrent force system, Parallelogram Law of forces, Principle of resolved parts, Numerical problems on composition of coplanar concurrent force systems, Composition of coplanar - non-concurrent force system, Varignon's principle of moments; Numerical problems on composition of coplanar concurrent force systems.

UNIT- 3 Equilibrium of Coplanar Forces [11hrs]

Definition of static equilibrium and Equilibrant, Conditions of static equilibrium for different coplanar force systems, Lami's theorem, Concept of Free Body Diagram, Numerical problems on equilibrium of coplanar – concurrent and non concurrent force systems.

UNIT- 4 Centroid and Moment of Inertia [12 hrs]

Introduction, Centroid of plane figures, Locating the centroid of triangle, semicircle, quadrant of a circle and sector of a circle using method of integration, Centroid of composite sections; Numerical problems. Moment of Inertia: Introduction to the concept, Rectangular and polar moment of inertia, Radius of gyration, Perpendicular axis theorem and Parallel axis theorem, Moment of Inertia of rectangle, circle, semi-circle, quarter circle and triangle from method of integration, Moment of inertia of composite areas, Numerical.

Text Books:

1. M. N. Shesha Prakash and Ganesh B. Mogaveer, "**Elements of Civil Engineering and Engineering Mechanics**", PHI Learning, 3rd Revised edition
2. A. Nelson, "**Engineering Mechanics-Statics and Dynamics**", Tata McGrawHill Education Private Ltd, New Delhi, 2009
3. S. S. Bhavikatti, "**Elements of Civil Engineering**", New Age International Publisher, New Delhi, 3rd edition 2009.
4. Rangawala S. C. "Engineering Materials", Charter Publishing House, Anand, India

Reference Books:

1. S. Timoshenko, D.H. Young and J.V.Rao, "**Engineering Mechanics**", TATA McGraw-Hill Book Company, New Delhi
2. Beer FP and Johnston ER, "**Mechanics for Engineers- Dynamics and Statics**", 3rd SI Metric edition, Tata McGraw Hill. - 2008 3. Shames IH, "**Engineering Mechanics–Statics & Dynamics**", PHI–2009.
3. S.K.Duggal, "**Building Materials**", (Fourth Edition) New Age International (P) Limited, 2016

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
B18ME2060	**Constitution of Indian and Professional Ethics**	FC	2	0	0	2	2

Prerequisites: pre-university level Constitution of India and Professional Ethics	Internal Assessment	Semester End Exam
	40 Marks	60 Marks

Course Objectives:

1. Provide and gain knowledge on Constitution of India
2. Discuss the Fundamental Rights, Duties and other Rights which is been given by our law.
3. Explain the practicality of Constitution perspective and make them face the world as a bonafide citizen.
4. Acquire knowledge about ethics and also know about professional ethics.
5. Explore ethical standards followed by different companies.

Course Outcomes:

By the end of the course student shall be able to

1. Explore the knowledge on Indian constitutional law and make the practical implementation of it.
2. Interpret the fundamental rights and human rights.
3. Explain the duties of a citizen and more importantly practise it in a right way.
4. Adapt the habit of raising their voice against a non-constitutionality of any laws and upon any legal discrimination.
5. Get exposed about professional ethics and know about etiquettes about it.
6. Acquire the knowledge of ethical standards of different companies which will increase their professional ability.

Course Content:

UNIT- 1 Constitution of India [8 hrs]

Definition, Making of Indian Constitution, Preamble to the Constitution of India, Fundamental Rights under Part III; Rights to Equality, Right to Freedom, Right against Exploitation, Rights to Freedom of Religion, Cultural and Educational Rights, Constitutional Remedies. Fundamental Duties of the Citizen, Significance and Characteristics. Elements of National Significance; National Flag, National Anthem, National Emblem.

UNIT- 2 Union and State: [7hrs]

Organs of the Government; Legislature, Executive and Judiciary. Union and State Executives: President, Vice President, Prime Minister, Supreme Court, Cabinet, Governor, Council of Ministers, Electoral process, Election Commission. Right to Information (RTI), Consumer and Consumer Protection.

UNIT- 3 Ethics: [7hrs]

Meaning, Definition, Evolution, Need of ethics, Aristotlean Ethics, Utilitarianism, Katianism, Professional Ethics, Personal Ethics and Business Ethics, Ethical Standards, Duties of Employers and Employees.

UNIT- 4 Engineering Ethics : [6hrs]

Definition Scope and needs, Ethics in Consumer Protection, Due Care theory, Environmental Ethics, Ethical Code of Conduct in ethics. Best Ethical Companiesin India and Abroad; Corporate Social Responsibilities,Code of Conduct and Ethical Excellence.

Text Books:

1. M V Pylee, An introduction to Constitution of India
2. M Govindarajan, S Natarajan, V S Senthil Kumar, Engineering

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
B18ME2070	**Technical English - II**	FC	0	0	2	2	4

	Internal Assessment	Semester End Exam
Prerequisites: Basic English	40 Marks	60 Marks

Course Objectives:

1. Demonstrate the ability of using language skills effectively in real-life scenarios.
2. To develop the learners competence in employability skills.

3. To elaborate the habit of writing, leading to effective and efficient communication.
4. To prioritize specially on the development of technical reading and speaking skills among the learners of Engineering and Technology.

Course Outcomes:

By the end of the course student shall be able to

1. Interpret opinions clearly and meaningfully.
2. Demonstrate the ability to speak appropriately in social and professional contexts.
3. Observe to build inferences from the text.
4. Interact in interviews confidently.
5. Develop accurate writing skills using different components of academic writing.

Course Contents:

UNIT- 1 Language Acquisition [14 Hrs]

Grammar: Active and passive voice, **Listening & Speaking:** Listening to informal conversations and interacting, **Reading:** Developing analytical skills; Deductive and inductive reasoning, **Writing:** Giving Instructions; Dialogue Writing.

UNIT- 2 Persuasive Skills [14 Hrs]

Grammar: Compound words; Phrasal verbs, **Listening:** Listening to situation based dialogues **Speaking:** Group Discussions, **Reading:** Reading a short story or an article from newspaper; Critical reading, **Writing:** Formal letters (Accepting/ inviting/ declining); Personal letters (Inviting your friend to a function, congratulating someone for his / her success, thanking one's friends / relatives).

UNIT- 3 Cognitive Skills [14 Hrs]

Grammar: Homonyms; homophones, **Listening:** Listening to conversations; Understanding the structure of conversations, **Speaking:** Presentation Skills, **Reading**: Extensive reading **Writing:** Report Writing (Feasibility/ Project report - report format – recommendations/ suggestions - interpretation of data using charts, PPT), Precis Writing.

UNIT- 4 Employability skills [14 Hrs]

Grammar: Idioms; Single Word Substitutes, **Listening:** Listening to a telephone conversation; Viewing model interviews (face-to-face, telephonic and video conferencing), **Speaking:** Interview Skills, Mock Interviews, **Reading:** Reading job advertisements and the profile of the company concerned, **Writing:** Applying for a job; Writing a cover letter with résumé / CV

Text Books:

1. Green, David. **Contemporary English Grammar Structures and Composition**. New Delhi: MacMillan Publishers, 2010.
2. Thorpe, Edgar and Showick Thorpe. **Basic Vocabulary**. Pearson Education India, 2012.
3. Leech, Geoffrey and Jan Svartvik. **A Communicative Grammar of English**. Longman, 2003.
4. Murphy, Raymond. Murphy's **English Grammar with CD**. Cambridge University Press, 2004.

Reference Books:

1. Bansal, R.K. and J.B. Harrison. **Spoken English.** Orient Blackswan, 2013.
2. Raman, Meenakshi and Sangeeta Sharma. **Technical Communication**. Oxford University Press, 2015.

3. Thorpe, Edgar and Showick Thorpe. **Objective English**. Pearson Education, 2013.\
4. Dixson, Robert J. **Everyday Dialogues in English**. Prentice Hall India Pvt Ltd., 1988.
5. Turton, Nigel D. **ABC of Common Errors**. Mac Millan Publishers, 1995.
6. Samson, T. (ed.) **Innovate with English**. Cambridge University Press, 2010.
7. Kumar, E Suresh, J. Savitri and P Sreehari (ed). **Effective English**. Pearson Education, 2009.
8. Goodale, Malcolm. **Professional Presentation.** Cambridge University Press, 2013.

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
B18ME2080	**Applied Physics Lab**	FC	0	0	2	2	3
Prerequisites: 10+2 Physics		Internal Assessment		Semester End Exam			
		20 Marks		30 Marks			

Course Objectives:

1. Expose practical knowledge of Physics to correlate with the theoretical studies.
2. Acquire perfectness in experimental skills relevance to the existing applications to improve confidence and ability to bring in advancement in fabricating new equipment's.
3. Demonstrate different measurement systems and on common types of errors.
4. Ascertain material characterization through standard techniques.

Course Outcomes:

By the end of the course student shall be able to

1. Extend skills to apply practical knowledge of Physics in real time solution.
2. Interpret the most appropriate measuring instruments for evaluation of various parameters.
3. Apply laws of hydrostatics in co relevance to practical considerations.
4. Determine various properties of different materials to authenticate the accuracy of evaluation technique.

List of Experiments:

1. Determination of acceleration due to gravity by Bar Pendulum.
2. Determination of Young's Modulus by single cantilever method/Uniform bending method.
3. Determination of Moment of Inertia and Rigidity Modulus by Static Torsion Method.
4. Determination of Tensile strength of mild steel.
5. Determination of viscosity of liquid by Poiseuille method.
6. Determination of Metacentric height of a floating body.
7. Determination Viscosity of given liquid using falling ball method.
8. Determination of surface tension of water by capillary rise method.
9. Calibration of pressure gauges.
10. Calibration of Thermocouple
11. Determination of modulus of elasticity of a mild steel specimen using strain gauges.
12. Study of photodiode characteristics/LVDT

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.

B18ME2090	‘C’ Programming Lab	HC	0	0	2	2	3

Prerequisites: Computer concepts	Internal Assessment	Semester End Exam
	20 Marks	30 Marks

Course Objectives:

1. Elaborate the basic Principles of Problem Solving using a Computer.
2. Demonstrate the Programming Constructs of ‘C’ Programming Language.
3. Explain the skills required to Design, Demonstrate and Implement Computable Problems / Mini-projects / Projects using ‘C’ Programming Language.
4. Provide the Arena for Development of Analytical, Reasoning and Programming Skills.
5. Set the Strong Foundation for Software Development in the field of Programming and hence to Create high quality ‘C’ Professionals.

Course Outcomes:

By the end of the course student shall be able to

1. Demonstrate basic principles of problem solving.
2. Interpret the presentation of numbers, alphabets and other characters in the memory of computer System.
3. Analyze Integrate, Apply and Demonstrate Software Development Tools, like Algorithms, Pseudo Codes and Programming Structures.
4. Analyze and Categorize the logical structure of a Computer Program, and hence to apply different programming constructs to develop a computer program using ‘C’ programming language;
5. Determine engineering solutions to simple (moderate) mathematical and logical problems using ‘C’ programming language;
6. Analyze, Integrate, Classify, Compare and Apply simple Data Structures, Pointers, Memory Allocation and Data Handling through files using ‘C’ programming language;
7. Determine the working of different Operating Systems; like Windows and Linux.
8. Enhance their Analytical, Reasoning and Programming Skills

List of Programs

1 a) Program to print the name, college name, Address of a student.
b) A company for aadhar card want’s to collect its employees information. Write a program to take input of employee name and age.

2 Program to read and print the size of variables of different data type.

3 Arithmetic operations are widely used in many programs. Write a program to perform addition, subtraction, multiplication, modulo division, and division operations.

4 A person has deposited some amount in bank. Write a program to calculate simple interest and compound interest on amount for a period.

5 In Delhi, four wheelers run on the basis of even or odd number. Write a program to identify whether vehicle registration number is even or odd.

6 People frequently need to calculate the area of things like rooms, boxes or plots of land where quadratic equation can be used. Write a program to find the coefficients of a quadratic equation and compute its roots.

7 Calculator allows you to easily handle all the calculations necessary for everyday life with a single application. Write a program to design a basic calculator that performs the basic operations and you want

to give choice to user to perform Addition of two numbers, Subtraction of two numbers Multiplication of two numbers, Division of two numbers, Wrong choice

8 In a stock market at the end of the day we do the summation of all the transactions.
   a. Write a program to display numbers (transactions) from1 to n.
   b. Write a program to find the sum of n natural numbers.

9 Read your ATM Pin Number. Write a program to identify your Pin Number is palindrome or not.

10 In computer based applications, matrices play a vital role in the projection of three dimensional image into a two dimensional screen, creating the realistic seeming motions. Write a program to perform matrix Multiplication and check compatibility of matrix.

11 You have joined a startup company of N employees; Write a program is to sort all employee id.

12 Suppose students have registered for workshop, and their record is maintained in ascending order based on student id. Write a program to find whether a particular Student has registered for that particular workshop or not.

13 In a memory game, you first enter a string wait for a time and again enter second string, Write a program to check both sting were same or not.

14 Read your first and last name in two different strings; Write a program to combine these two strings into third string.

15 Write a C program to create a line of given length or co-ordinates, and to perform 2D transformations such as translation, scaling and rotation on a line.

16 Write a C program to create a circle of given diameter and center co-ordinates and to perform 2D transformations such as translation and scaling on a circle.

17 Write a C program to create an ellipse of given major diameter, minor diameter and center co-ordinates and to perform 2D transformations such as translation, scaling, and rotation on an ellipse.

18 Write a C program to create a rectangle of given dimensions and to perform 2D transformations such as translation, scaling, and rotation on a rectangle.

THIRD SEMESTER

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
B18ME3010	Numerical Methods and Probability	HC	2	1	0	3	4
Prerequisites: Engineering Mathematics		Internal Assessment			Semester End Exam		
		40 Marks			60 Marks		

Course Objectives:

1. Learn to solve algebraic, transcendental equations and finite difference, interpolation and its application.
2. Learn to solve ordinary differential equations numerically using different methods.
3. Learn the concept of Random variables and probability distributions.
4. Construct the various tests essentially needed for the testing of small samples for the testing of hypothesis.

Course Outcomes:

By the end of the course student shall be able to

1. Describe the basics of numerical methods and their applications.
2. Exercise the problems of algebraic, transcendental equation and use a given data for equal and unequal intervals to find a polynomial function for estimation.
3. Apply Interpolation technique to approximate the value of the integral for the functions.
4. Exercise the problems of ordinary differential equations using various methods.
5. Apply the concepts of probability distribution to solve the engineering problems.

Course Content:

UNIT-I Numerical Analysis [11hrs]

Solution of algebraic and Transcendental equation- Regula- falsi method, Newton-Raphson method.

Finite differences and Interpolation:-Forward and Backward differences, Newton's forward and Backward interpolation formulae. Divided differences-Newton's divided difference formula. Lagrange's Interpolation formula and Inverse Interpolation formula and Problems.(All formulae without proof).

UNIT -2 Numerical Differentiation and Integration [12hrs]

Numerical Differentiation and Integration: Derivatives using Newton's forward and backward difference formula.

Numerical Integration: Trapezoidal Rule, Simpson's $1/3^{rd}$, $3/8^{th}$ Rule, Weddle's formula and Problems.

Numerical solutions to ODE: First order and first degree, Picards Method , Taylor's series method , Modified Euler's method , Runge-Kutta method of fourth order, Adam's-Bashforth Predictor-corrector method and Problems.

UNIT-3 Probability Distributions and Sampling Theory [11hrs]

Random variables (discrete and continuous), Probability density function, probability distribution – binomial and Poisson's distributions; exponential and normal distributions.

Sampling, Sampling distributions, standard error, test of hypothesis for means and confidence limits, Student's t-distribution and Chi-square distributions.

UNIT-4 Joint Distribution and Markov's Chain [11hrs]

Joint Probability Distribution:-Concept of joint probability, joint distributions –discrete random variables, independent random variables, problems on expectation and variance.

Markov's Chains: Probability vectors, stochastic matrices, fixed points and regular stochastic matrices, higher transition Probability, stationary distribution of regular Markov's Chains absorbing states.

Text books:

1. B.S. Grewal, "**Higher Engineering Mathematics**", Khanna Publishers, 43nd edition, 2015.
2. Erwin Kreyszig, "**Advanced Engineering Mathematics**", Wiley Publications, 10th edition, 2015.

Reference Books:

1. B.V. Ramana, "**Higher Engineering Mathematics**", Tata McGraw Hill Publications, 19th edition, 2013.
2. R.K. Jain and S.R.K. Iyengar, "**Advanced Engineering Mathematics**", Narosa Publishing House, 5th edition, 2014.

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
B18ME3020	**Mechanics of Materials**	HC	3	0	1	4	5
Prerequisites: Engineering Mechanics		Internal Assessment			Semester End Exam		
		40 Marks			60 Marks		

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Course Objectives:

1. To teach the students knowledge of simple stresses, strains and deformations components due to external loads and study on the behavior of ductile and brittle materials.
2. To enable to assess stresses and deformations of Compound stresses, Thin pressure vessels and Torsion
3. To teach the students knowledge of Shear Force, Bending Moment Diagram and Bending stress
4. To teach the students knowledge of beams, Columns & Struts
5. To Provide the Basic knowledge for use in the design courses.

Course Outcomes:

By the end of the course the student shall be able to

1. Describe the basic meaning of stress, strain diagrams for engineering materials.
2. Compute stress distribution in thin pressure vessels, identify the stresses in torsional members and determine principal stresses in two dimensional systems.
3. Construct the shear force and bending moments for the beam.
4. Determine the Deflections in beams, Columns & Struts.

Course Content:

UNIT-1 Simple Stresses, Strains and Elastic Constants [12 hrs]

General meaning of stress, types of simple stresses and strains. Stress- strain diagrams for Engineering materials, Hooke's law, Extension/shortening of bars, Principles of super positions, compound bars.

Lateral strain, Poisson's ratio, volumetric strain, Bulk modulus, Shear modulus, Young's modulus and their relations. Temperature stresses in compound bars.

UNIT-2 Compound stresses, Thin Pressure Vessels and Torsion [11 hrs]

Stresses in two dimensional system, plane Stress transformation, Principal planes, principal stress and principal strain, Maximum shear stress Analytical and Graphical approach.

Stresses in thin pressure vessels, Pure Torsion, Torsion equations and applications, simple numerical

UNIT-3 Shear Force, Bending Moment Diagram and Bending Stress [11 hrs]

Introduction, relationship between shear force and bending moments, shear force and bending moment diagrams for different beams subjected to various loads.

Theory of Simple Bending (Bending equation/ Flexural Formula), Section Modulus, Applications of Bending Equation, Beams of uniform strength.

UNIT-4: Deflections in Beams, Columns and Struts [12 hrs]

Beam Deflection, Relation between Slope, Deflection and Radius of Curvature, Slope and Deflection at a Section using Double Integration Method and Macaulay's method for simply supported, cantilever beams.

Columns, concept of buckling, application of Euler's formulae, Rankin formula to columns under various end conditions.

Text Books:

1. Beer & Russell Johnstan "**Mechanics of Materials**", , in S.I. Units, Ferdinand TATA Mc GrawHill- 2003.
2. S.S.Bhavikatti,"**Strength of Materials**", Vikas publications House -1 Pvt. Ltd., 2nd Ed., 2006.
3. R K Bansal "**Engineering Mechanics and Strength of Materials**", Laxmi Publications-New Delhi (2004)

Reference Books:

1. R.C.Hibbeler,"**Mechanics of Materials**", Printice Hall. Pearson Edu., 2005
2. S Ramamrutham, R Narayana, "**Strength of Materials**", Dhanphatrai publishing Co.Ltd.2003
3. Timoshenko.S.P "**Strength of Materials**", Part1,D.Van Nostrand company, Inc.Newyork

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
B18ME3030	**Engineering Thermodynamics**	HC	3	1	0	4	5
Prerequisites: Physics		Internal Assessment		Semester End Exam			
		40 Marks		60 Marks			

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Course Objectives:

1. The course aims at to cover the basic principles of thermodynamics, to give students a feel for how thermodynamics is applied in engineering practice.
2. To develop an intuitive understanding of thermodynamics by emphasizing the physics and physical arguments.
3. To learn the basics of heat engine, heat pump, refrigerator and Carnot principle and their Practical applications.
4. To describe the concept of entropy and its importance in practical applications.
5. To teach students about properties of pure substances and process related to vapor.

Course Outcomes:

By the end of the course the students should be able to

1. Describe the fundamental concepts of thermodynamic systems and various processes of heat and work interactions
2. Discuss of the First law of thermodynamics and analysis of flow processes in different applications
3. Discuss of the second law of thermodynamics and analysis in different applications
4. Calculate entropy for various simple real life systems.
5. Define the properties of pure substances.

Course Content:

UNIT-1 Fundamental Concepts, Work and Heat [11 hrs]

Thermodynamic definition and scope, Microscopic and Macroscopic approaches, types of systems and control volume, examples. Thermodynamic properties- intensive , extensive properties, specific properties, thermodynamic state and process, quasi-static process, Reversible and Irreversible process, cyclic and non-cyclic processes, Thermodynamic equilibrium , Zeroth law of thermodynamics, Temperature concepts and scales, Mechanics definition of work and its limitations. Thermodynamic definition of work, sign convention, Displacement work; expressions for displacement work in various processes through p-v diagrams, Other forms of work- Electrical work, shaft work, spring work and flow work. Heat, units and sign convention, Work and Heat as path functions. Problems on work transfer.

UNIT-2: First Law and Second Law of Thermodynamics [11hrs]

Joules experiments, Statement of the First law of thermodynamics, First law to non - cyclic processes, Energy: energy as a property, Types of Energy, Relationships between Cp, Cv, γ and R, Extension of the First law to control volume; steady flow energy equation(SFEE)- Applications on SFEE. Limitations of first law of thermodynamics, PMM I. Direct Heat engine and Reversed Heat engine. Kelvin – Planck and Clausius statement of the Second law of Thermodynamics; and PMM II, Equivalence of the two statements; Carnot cycle, Carnot theorem. Absolute Temperature scale, Problems on I and II law of Thermodynamics.

UNIT-3: Entropy and Ideal Gases [11hrs]

Introduction to entropy, Clausius theorem, Clausius inequality, Entropy as a property, Temperature-Entropy diagram, representation of Carnot cycle on T-S diagram; principle of increase of entropy, The T-ds equations; Equations for change in entropy during thermodynamic processes; Ideal gases-evaluation of properties of perfect and ideal gases, Discussions on Ideal Gas mixtures- Daltons law of partial pressures, Amagat's Law of Additive volume, Properties of Ideal gas mixtures, Problems on Entropy and Ideal Gases.

UNIT-4: Pure Substances and Real Gases [12 hrs]

Pure substance; two property rule, vapour formation- T-V and P-T diagrams, critical and triple points, Properties of Steam: dryness fraction, Internal energy, Enthalpy, work done during evaporation , entropy. steam tables, problems on Vapour processes- Steam calorimeters- throttling, combined separating and throttling calorimeters, problems. Real Gases: Van-der Waal's Equation of state, Van-der Waal's constants in terms of critical properties, Law of corresponding states, compressibility factor; generalized compressibility chart, Problems.

Text Books:

1. P K Nag, (2002) **Basic and Applied Thermodynamics** Tata McGraw Hill.
2. Yunus A Cenegal,(2012) **Thermodynamics an Engineering Approach** by Yunus A Cenegal, Tata McGraw Hill.

Reference Books

1. Y.V.C.Rao, (2004**), an Introduction to Thermodynamics,** Universities Press.
2. R K Rajput, (2016) **Thermal Engineering** Laxmi Publications.
3. C. P. Arora, (2005) **Thermodynamics**, Tata McGraw-Hill Publishing Company Ltd.
4. Mahesh M Rathore, **Thermal Engineering**, Tata McGraw-Hill publications

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
B18ME3040	**Fluid Mechanics and Fluid Machinery**	HC	2	0	1	3	4
Prerequisites: Engineering Physics, Engineering Thermodynamics		Internal Assessment			Semester End Exam		
		40 Marks			60 Marks		

Course Objectives:

1. To identify the flow characteristic and dynamics of flow field for various Engineering Applications.
2. To recall how velocity changes and energy transfers in fluid flows are related to forces and torques and
3. To discuss why designing for minimum loss of energy in fluid flows is so important.
4. To discuss the main properties of laminar and turbulent pipe flow and appreciate their differences and the concept of boundary layer theory.
5. To describe the concept of dynamic similarity and how to apply it to experimental modeling

Course Outcomes:

By the end of the course, the student shall be able to

1. Apply the knowledge of kinematics and dynamics while addressing problems of mechanical and chemical engineering.
2. Generalize and apply the principles of fluid kinematics and dynamics.
3. Discuss the concept of boundary layer in fluid flow and apply dimensional analysis to form dimensionless numbers in terms of input output variables.
4. Describe the basic concept of Impact of jets, Centrifugal pumps.
5. Describe the basic concept Hydraulic turbines

Course Content:

UNIT-1: Fluid Kinematics, Dynamics and Dimensional Analysis [11 hrs]

Fluid Kinematics: Stream lines, path lines, streak lines Types of Flow, velocity components, Discussion on convective and local acceleration, velocity potential, stream function,3-dimensional Continuity equation in Cartesian co-ordinates.

Fluid Dynamics: Euler's equation of motion along stream line, Bernoulli's equation and its limitations, Applications of Bernoulli's theorem such as venturi meter, orifice meter ,Pitot tube, Rectangular and triangular notch, , related numerical.

Dimensional Analysis: Dimensions and units, Dimensional Homogeneity methods of dimensional analysis, Rayleigh's method, Buckingham π theorem, Discussion on Similitude and Model studies, Dimensionless numbers, Numerical.

UNIT -2: Flow Through Pipes, Viscous Flow, Flow Around Bodies [11 hrs]

Energy consideration in pipe flow, Loss of Pressure Head due to Fluid Friction- Darcy Weisbach equation & Chezy's formula, Discussion on minor losses in pipes, HGL and TEL related numerical.

Laminar and turbulent flow: Reynolds Number, Navier-Stokes Equation (no derivation), Laminar flow between parallel plates, fully developed laminar flow in circular pipes, Hagen – Poiseuille equation, related numerical.

Basic concept of Lift and Drag: Types of drag, Co-efficient of drag and lift, streamline body and bluff body, Discussion on flow around circular bodies and aero foils, Lift and drag on aero foil, Numerical.

UNIT -3: Impact of Jets and Centrifugal Pumps [11 hrs]

Impact of Jets: Introduction, Force exerted by the jet on a stationary and moving vertical plate, unsymmetrical curved vane at the centre and tangentially at one of the tip. Force exerted by jet of water on unsymmetrical moving curved vane when jet strikes at centre and tangentially at one of the tips., Force exerted by a jet of water on series of plate, Generalized fluid flow through fluid machines and the velocity components, Illustrative examples.

Centrifugal Pumps: Classification and parts of centrifugal pump, different heads and

Efficiencies of centrifugal pump, Minimum speed for starting the pump, Net positive suction head, Cavitation, Need for priming, Pumps in series and parallel, Numerical.

UNIT -4: Hydraulic Turbines [12 hrs]

Classification, efficiencies of hydraulic turbines. Pelton turbine – velocity triangles, design parameters, Maximum efficiency, Francis turbine - velocity triangles, design parameters, Kaplan and Propeller turbines – velocity triangles, design parameters. Draft tubes- Types and functions, Discussion on Micro turbines, Problems.

Text Books:

1. Dr. Bansal, **Fluid Mechanics and Machinery**, R.K.Lakshmi Publications, 2004.
2. Jagadish Lal **Fluid Mechnaics and Hydraulic** , Metropolitan Book Company

Reference Books:

1. Yunus A. Cengel John M.Cimbala, **Fluid Mechanics** (SI Units), 3rd Ed., TataMcGraw Hill, 2014.
2. Pijush.K.Kundu, **Fluid Mechanics**, IRAM COCHEN, ELSEVIER, 3rd Ed. 2005

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
B18ME3150	Material Science and Metallurgy	HC	3	0	0	3	3

Prerequisites: Physics	Internal Assessment	Semester End Exam
	40 Marks	60 Marks

Course Objectives:

1. To provide the basic knowledge required to explore the materials science and engineering.
2. To enhance the knowledge of the structure of materials which includes crystallography, microstructure, defects, and phase diagrams.
3. To develop the knowledge about the heat treatment process required for the metals.
4. To incorporate the knowledge in various class of materials and their applications.

Course Outcomes:

By the end of the course student shall be able to

1. Recognize the classification of materials based on atomic arrangement and
2. Behavior of materials in elastic and plastic regions.
3. Illustrate the mechanism of solidification for various alloys.
4. Identify the different phases of iron and apply required heat treatment process for the industrial purposes.
5. Enumerate the knowledge on different class of materials and their failures.

Course Content:

UNIT-1: Crystalline Structure and Crystal Defects [11 hrs]

Introduction, Seven Systems and fourteen lattices, Metal structures, Ceramic Structures, Polymeric structures, Semiconductor structures, Lattice positions, Directions and planes.The solid solution-chemical imperfection, Point defects-zero dimensional imperfections, Linear defects or dislocation-one dimensional imperfections, Planar defects-Two dimensional imperfections, Nanocrystalline solids-Three dimensional imperfections. Introduction to Microscopy, XRD & SEM.

UNIT–2: Solidification and Phase Diagrams [11 hrs]

Mechanism of solidification, homogeneous and heterogeneous solidification, Hume Rothary rules substitution and interstitial solid solutions. Construction of phase diagram for two component systems, application of Gibbs phase rule. Construction of phase equilibrium diagram involving complete and partial solid solubility, application of lever rule. (with numerical), Iron carbon equilibrium diagram and invariant reactions.

UNIT-3: Heat Treatment of Metals and Alloys [11 hrs]

Heat treatment of metals: Annealing method and its types. Normalizing, hardening, tempering, martempering, austempering. Hardenability, surface hardening methods like carburizing, cyaniding, nitriding, flame hardening and induction hardening, age hardening of aluminium-copper alloys- Methods with applications

UNIT-4: Mechanical Behavior of Materials [12 hrs]

Stress – strain diagram for ductile and brittle materials, elastic and plastic deformation, mechanical properties in elastic and plastic region, linear and non-linear properties (no numerical)

Creep – Phenomenon, stages of creep and creep properties. Fatigue- Types of fatigue loads, fatigue properties, Fatigue test and S- N curves.

Fracture: Mechanism of fracture, ductile and brittle fracture, Griffith's theory of fracture (only derivation), ductile to brittle transition.

Text Books:

1. James F Shackleford.,& Madanapalli K Muralidhara, **Material science for Engineers,** Sixth edition, Pearson Publications - 2007
2. Smith, **Foundations of Materials Science and Engineering,** 4th Edition McGraw Hill, 2009.

Reference Books:

1. Alan Cottrell **An Introduction to Metallurgy** Universities Press India Oriental Longman Pvt. Ltd., 1974.
2. W.C.Richards **Engineering Materials Science**, PHI, 1965
3. V.Raghavan **Materials Science and Engineering**, , PHI, 2002
4. William D. Callister Jr., **Materials Science and Engineering**, John Wiley & Sons. Inc, 5th Edition, 2001.
5. Traugott Fischer, **Materials Science for Engineering Studies,** 2009. Elsevier Inc

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
B18ME3160	**Computer Aided Machine Drawing**	HC	1	0	2	3	5
Prerequisites: Computer Aided Engineering Drawing		Internal Assessment		Semester End Exam			
		40 Marks		60 Marks			

Course Objectives:

1. Understand drawing and develop capacity to represent any matter/object with the help of picture.
2. Develop primary knowledge of working drawing.
3. Produce orthographic drawing of different machine parts.
4. Develop skill to produce assembly drawings.
5. To enable students to draw the assembly of various Mechanical machine components.

Course Outcomes:

By the end of the course student shall be able to

1. Analyze graphical knowledge.
2. Draw the machine elements like Fasteners and Joints.
3. Draw the machine elements Joints and Couplings.
4. Analyze and draw assembly drawings.

Course Content:

UNIT–1: Orthographic Views and Thread Forms [11 hrs]

Orthographic Views: Conversion of pictorial views into orthographic projections of simple machine parts with or without section. (Bureau of Indian Standards conventions are to be followed for the drawings).
Thread Forms: Thread terminology, sectional views of threads: ISO Metric (Internal & External) BSW (Internal & External) square and Acme. Sellers thread, American Standard thread.

UNIT-2: Fasteners and Joints [11 hrs]
Fasteners: Orthographic projection of Hexagonal headed bolt and nut with washer (assembly), square headed bolt and nut with washer (assembly).
Joints: Single and double riveted lap joints, butt joints with single/double cover straps (Chain and Zigzag, using snap head rivets).

UNIT -3: Joints and Couplings [11 hrs]
Cotter joint (Single Cotter) (socket and spigot), knuckle joint (pin joint) for two rods,
Couplings: Split Muff coupling, Protected and Unprotected type flanged coupling, Basics of GD&T.

UNIT–4: Assembly Drawing [12 hrs]
Screw jack (Bottle Type)(Demo), Machine vice. I.C. Engine connecting rod, Plummer block (Pedestal Bearing), Feed Check Value, Rams Bottom safety Valve, Tailstock of lathe, Lathe Square tool post.

Text Books:
1. N D Bhat and V.M. Panchal, **Machine Drawing** Published by Charotar Publishing house-1999
2. Robert C Juvinall and Kurt M Marshek, "**Machine Component** Design" Wiley publications.

Reference Books:
1. K R Gopalakrishna **"Machine Drawing"** – Subhash publishers, Bangalore.
2. Sham Tickoo, **"CAD for Engineers and Designers",** Dream Tech 2005.
3. N Siddeshwar, P.Kanniah, V.V.S Sastri, "**Machine Drawing**" Published by TATA McGraw Hill,2006

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
B18ME3170	**Materials Testing and Characterization Lab**	HC	0	0	2	2	3
Prerequisites: Material Science, Mechanics of Materials		Internal Assessment			Semester End Exam		
		20 Marks			30 Marks		

Course Objectives:

1. To prepare the specimen for metallographic examination
2. To study the wear characteristics of the given specimen
3. To study the tensile , compressive and shear prosperities of metals and non metals
4. To evaluate Brineel, Vicker's and Rockwell's hardness of the materials
5. To find impact strength of the given material
6. To find the endurance limit of the material

Course Out comes:

By the end of the course the student shall be able to
1. Identify the type of material based on the microstructure using optical microscope.
2. Evaluate the wear properties.

3. Determine the defects in the given specimen using Ultrasonic flaw detection, Magnetic crack detection and Dye penetration test.
4. Determine tensile, compressive, torsional and bending properties of the given material using UTM.
5. Determine hardness of the given material & impact strength of the given material

List of Experiments

PART – A

1. Preparation of specimen for Metallograpic examination of different engineering materials. Identification of microstructures of plain carbon steel, tool steel, gray C.I, SG iron, Brass, Bronze & composites.
2. To study the wear characteristics of ferrous, non-ferrous and composite materials for different parameters.
3. Non-destructive test experiments like,
   a. Ultrasonic flaw detection
   b. Magnetic crack detection
   c. Dye penetration testing. To study the defects of Cast and Welded specimens

PART – B

1. Tensile, shear and compression tests of metallic and non metallic specimens using Universal Testing Machine
2. Torsion Test
3. Bending Test on metallic and nonmetallic specimens.
4. Izod and Charpy Tests on M.S,& C.I Specimen.
5. Brinell, Rockwell and Vickers's Hardness test.
6. Fatigue Test.

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
B18ME3180	**Casting and Forging Lab**	HC	0	0	2	2	3
Prerequisites: Manufacturing Technology		Internal Assessment			Semester End Exam		
		20 Marks			30 Marks		

Course Objectives:

1. The course will introduce desirable properties of molding sand and establish its relevance in preparing the sand mold.
2. To introduce the experimental procedure in determining the GFN, Permeability, Strength of mold, moisture & clay content in sand sample, core hardness & mold hardness.
3. To bring in the effect of clay & water content on the various properties of molding sand.
4. To give students hands on practice in preparing the sand moulds (Cope & Drag box) using single piece, split pattern and without using pattern.
5. To give students hands on practice in preparing forging models using open -hearth furnace by performing upsetting, drawing & bending operation.

Course Out comes:

By the end of the course the student shell be able to

1. Describe general properties of molding sand.
2. Illustrate the influence of Grain fineness of the silica sand used in the preparation of the mold

3. Determine the compression, shear, tensile strength & permeability of a molding sand for different proportion of clay.
4. Determine the percentage of clay & moisture content for a given sand sample
5. Identify the different tools used in foundry & Forging practice with their uses
6. List the different stages involved in preparing the sand mold box & forged model
7. Create the sand mold cavity using cope & drag box with pattern or without pattern
8. Demonstrate the upsetting, drawing & bending operation in preparing the forged model

List of Experiments

PART – A

1. Testing of Moulding Sand and Core Sand:

Preparation of sand specimens and conduction of the following tests:

a. Compression, Shear and Tensile tests on Universal Sand Testing Machine.
b. Permeability test
c. Core hardness & Mould hardness tests.
d. Sieve Analysis to find Grain Fineness number of Base Sand
e. Clay content determination in Base Sand

PART – B

2. Foundry Practice

a. Use of foundry tools and other equipments.
b. Preparation of moulds using two moulding boxes using patterns or without patterns. (Single piece Split pattern, and hand cut)
c. Preparation of one casting (Aluminum or cast iron-Demonstration only)

PART – C

3. Forging Operations:

a. Calculation of length of the raw material required to do the model.
b. Preparing minimum three forged models involving upsetting, drawing and bending operations.

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
B18ME3250	**Mechanical Measurements and Metrology**	HC	3	0	0	3	3
Prerequisites: Basic knowledge on physics		Internal Assessment			Semester End Exam		
		40 Marks			60 Marks		

Course Objectives:

1. To impart the knowledge of importance of standards & conversion.
2. To introduce the fundamental concepts & derive the relations for the design of gauges, types of gauges, concepts involving comparators, angular measurements,
3. To elaborate the fundamental methods of measurement, concept of transducer & terminating devices, exposure to the errors, classification & remedies.
4. To explore the various aspects regarding the strain & temperature measurement

Course Outcomes:

By the end of the course students shall be able to

1. Explain the need, history for the development of new concepts of metrology and measurement,record and interpret the data.
2. Demonstrate the fundamentals of standards, comparison between the standards and unknown quantity.
3. Explain the concepts of error and accuracy.
4. Apply the skills in measuring strain and temperature measurement..

Course Content:

UNIT-1: Basic of Metrology, Linear and Angular Measurement [11 hrs]

Objectives of metrology, role of standards, standards of length- International prototype meter, Imperial standard yard, wave length standard, subdivision of standards, line & end standard, calibration of end bars (numerical), Slip gauges, Wringing phenomenon, Numerical problems on building of slip gauges, Vernier bevel protractor, Angle gauges, Sine principle, Sine bar & Sine Centre.

UNIT-2: System of limits, Fits, Tolerance, Gauging and Comparators [11 hrs]

Need of limit system, Tolerance, Specification of tolerance in assembly, Accumulation tolerance & compound tolerance, principle of interchangeability & selective assembly, concept of limit of size & tolerance, Concept of fits, types of fits, shaft basis & hole basis system, geometric tolerance, tolerance grade, Numerical problem on limits and fits. Taylor's principle, introduction to comparators, need, characteristics, classification of comparators, Johanson Mikrokator, Zeisss ultra optimeter, Solex, LVDT.

UNIT-3: Temperature, Strain Measurement [11 hrs]

Introduction, resistance thermometer, thermocouple, law of thermocouple, materials used for construction, Pyrometer, optical pyrometer, radiation pyrometer,

Strain measurement, strain gauge, preparation & mounting of strain gauges, electrical strain gauge, backing & bonding materials.

UNIT-4: Advancement in Metrology [12 hrs]

Introduction, Direct method: Analytical balance, unequal arm balance, proving ring. Torque measurement: Mechanical, hydraulic dynamometer, Pressure measurements, principle, Bridgeman gauge, McLeod gauge, Pirani gauge. Introduction to advancement in metrology, lasers in metrology, advantages of lasers, laser scan micrometer, applications- straightness, alignment, ball bar test, Machine vision, basic concept of machine vision system, elements, applications.

Text Books:

1. Beckwith Marangoni and Lienhard, **Mechanical Measurements**, Pearson Education, 6th Ed., 2006.
2. R.K. Jain, **Engineering Metrology**, Khanna Publishers, 1994.
3. B.C Nakra **Instrumentation, Measurement & Analysis**, , K K Choudhary, 4th Edition, McGraw-Hill.
4. I.C.Gupta, **Engineering Metrology** Dhanpat rai publications.

Reference Books:

1. Bently, **Engineering Metrology and Measurements**, PearsonEducation.
2. Anand K. Bewoor & Vinay A. Kulkarni **Metrology & Measurement**, Tata McGraw.
3. N.V Raghavendra & L. Krishnamurthy, **Engineering Metrology and Measurements,** Oxford University Press.

4. Gupta I.C, **Engineering Metrology,** Dhanpat Rai Publications, Delhi.
5. R.K Jain **Mechanical Measurement**, Khanna Publishers. 1994

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
B18ME3260	**Theory of Metal Cutting and Machine Tools**	HC	3	0	0	3	3
Prerequisites: Manufacturing Technology		Internal Assessment			Semester End Exam		
		40 Marks			60 Marks		

Course Objectives:

1. To familiarize the student with tool nomenclature and cutting forces
2. To impart knowledge of mathematics on machining parameters for different machining processes, tool life and tool wear.
3. To acquire the knowledge about various machining processes for production of complex shaped components.
4. To predict a suitable super finishing process to produce the intricate components.

Course Outcomes:

By the end of the course student shell be able to

1. Analyze forces acting on the cutting tool in orthogonal and oblique cutting
2. Examine various process parameters to improve the cutting tool life
3. Ascertain the knowledge and need of super finishing process.
4. Identify the driving mechanism of different machine tools.

Course Content:

UNIT -1: Theory of Metal Cutting [11 hrs]

Introduction -Geometry of a single point cutting tool - Chip formation and types of chips–Orthogonal and oblique cutting – Merchant circle diagram for cutting forces - Shear angle in terms of chip thickness ratio and rake angle –Problems on shear angle - Machining variables – Factors affecting cutting tool life – Types of tool wear – Taylor's tool life equation – Problems on Taylor's tool life equation. Cutting tool materials of common use and their characteristics – Functions of cutting fluids – Types of cutting fluids – Heat generation in metal cutting and factors affecting heat generation – Measurement of tool tip temperature using tool work thermocouple technique.

UNIT -2: Lathe , Drilling and Shaping Machine [11 hrs]

Lathe: Working principle and specifications of lathe, Description of main components and lathe operations, Work holding devices. Constructional features of turret and capstan lathe. Automatic Lathe.

Drilling Machine-Principle of working, Classification, construction and working of Bench and Radial drilling machines, drilling operations, drill bit nomenclature, simple problems,

Shaping Machine: Introduction, types, construction and operations of horizontal shaper.

UNIT -3: Milling and Grinding Machine [11 hrs]

Milling: Principle of working, Classification of Milling machines, construction and working of Horizontal and vertical milling machines. Milling operations, methods of indexing simple and compound-problems on simple indexing.

Grinding: Working principle, constructional features of Cylindrical, Centerless and Surface grinding machines, Types of abrasives, Grinding operations- dressing, truing.

UNIT -4: Lapping, Honing and Broaching Machines [12 hrs]

Lapping – Principle of Lapping – Lapping methods – Advantages and limitations of lapping

Honing – principle of honing – Types of honing machines – Advantages, limitations and applications of honing.

Broaching – Principle of working – Details of a commonly used broach – construction and working of a horizontal broaching machine – Advantages, limitations and applications

Text Books:

1. Hajra choudhury, **Workshop Technology Vol-II**, Media Promoters & Publishers Pvt. Ltd. 2004
2. R.K Jain, **Production Technology**, Khanna Publications, 2003.
3. HMT, **Production Technology**, Tata McGraw Hill, 2001.
4. O.P Khanna,**Production Technology Vol-1**, Dhanpat Rai publications
5. Rajput,**Manufacturing Technology** Second edition, Laxmi Publications

Reference Books:

1. Amitabh Ghosh and Mallik **Manufacturing Science**, , affiliated East West Press, 2003
2. G. Boothroyd, **Fundamental of Metal Machining and Machine Tools**, McGraw-Hill, 2000.
3. G.C Sen & Bhattacharya **Principle of Machine Tools**, Tata Mcgraw hill, New Delhi
4. Kalpakjian, serope **Manufacturing Engineering and Technology**, Addison –wesley publishing co., New york
5. P.C Pandey & H.S Shan **Modern Machining Processes**:, T.M.H Company, New Delhi

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
B18ME3270	**Fluid Machinary Lab**	HC	0	0	2	2	3
Prerequisites: Fluid Mechanics		Internal Assessment			Semester End Exam		
		20 Marks			30 Marks		

Course Objectives:

1. To understand the various fluid flow measuring devices and find discharge.
2. To learn the testing procedure of the pumps and compressor.
3. To learn the procedure used to conduct performance test of the turbines.
4. To understand the performance characteristics of the fluid machineries.

Course Outcomes:

By the end of the course the student shell be able to

1. Identify the devices which are used for measurement of discharge.

2. Differentiate the pumps based on the working principle
3. Conduct the performance test on the turbine and compare the results in terms of performance curves.
4. Explain the working principle of the turbines and pumps.
5. Write the procedure involved in conducting the performance.

List of Experiments

1. Determination of friction factor and Reynold's number for the fluid flowing through pipes. (Major losses)
2. Determination of friction Co-efficient of given pipe fittings and bends for fluid flowing through pipes. (Minor losses)
3. Determination of co-efficient of impact of jet on vanes.
4. Determination of co-efficient of discharge of given circular orifice.
5. Determination of co-efficient of discharge of given venturimeter.
6. Determination of co-efficient of discharge of given nozzle.
7. To calibrate of given Rotameter.
8. Performance test on Single stage Centrifugal pump to draw Main and Operating characteristic curves
9. Performance test on Multi- stage Centrifugal pump to draw Main and Operating characteristic curves
10. Performance test on Reciprocating pump to draw Operating characteristic curves
11. Performance test on Pelton turbine to draw Main and Operating characteristic curves
12. Performance test on Francis turbine to draw Main and Operating characteristic curves
13. Performance test on Kaplan turbine to draw Main and Operating characteristic curves

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
B18ME3280	**Metal Cutting and Machine Tool Lab**	HC	0	0	2	2	3
Prerequisites: Theory of Metal Cutting & Machine Tools		Internal Assessment			Semester End Exam		
		20 Marks			30 Marks		

Course Objectives:

1. To understand various operations carry out through various machines.
2. To provide knowledge about various machine tools.
3. To learn turning, milling and shaping operations.
4. To prepare the model as per the given dimensions

Course Out comes:

By the end of the course the student shall be able to

1. Identify the various operations require to prepare the model.
2. Select the suitable machine for a particular operation.
3. Prepare the specimen as per the given dimension for the given raw material.
4. Work in a manufacturing industry.

List of Experiments

PART-A

1. Preparation of various models on lathe involving Plain turning, Taper turning, Step turning, Thread cutting, Facing, Knurling, Drilling, Boring, Internal Thread cutting and Eccentric turning.

PART-B

2. Cutting of V Groove/ dovetail/Rectangular groove using a shaper.
3. Cutting of Gear Teeth Using Milling Machine

PART-C (Demo only)

1. Lathe tool dynometer
2. Drill tool dynometer
3. Effective diameter measurement-Two wire method
4. Taper measurement using Sine bar
5. Taper measurement using Sine center
6. Gear Tooth Vernier

FOURTH SEMESTER

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
B18ME4010	**Applied Mathematics**	HC	2	1	0	3	4
Prerequisites: Advanced Mathematics		Internal Assessment			Semester End Exam		
		40 Marks			60 Marks		

Course Objectives:

1. Formulate, solve and analyze engineering problems.
2. Understand the fundamental concepts of Complex Analysis such as analytic functions, complex integrals and a range of skills which will allow students to work effectively with the concepts.
3. To study and understand the application approach of the concepts of Fourier series.
4. To study and understand the application approach of the concepts of Fourier transforms.
5. Apply numerical methods to solve differential equations.

Course Outcomes:

By the end of the course the student shall be able to

1. Apply appropriate numerical methods to solve first, second order ode and partial differential equations.
2. Apply Cauchy's integral theorem and formula to compute line integrals.
3. Apply techniques of Fourier series to solve problems of mechanical engineering.
4. Apply techniques of Fourier transform to solve problems of mechanical engineering.

Course Content:

UNIT –1 Complex Analysis [11 hrs]

Function of a complex variable, Analytic functions-Cauchy-Riemann equations in Cartesian and polar forms (No proof C-R equations). Properties of analytic functions. Complex line integrals-Cauchy's theorem, Cauchy's integral formula and problems. Poles and residues. Cauchy's residue theorem (without proof)- problems

UNIT –2 Fourier series [12 hrs]

Periodic functions, Dirichlet's condition, Fourier Series of periodic functions with period 2π and with arbitrary period $2l$. Fourier series of even and odd functions. Half range Fourier Series, practical harmonic analysis-Illustrative examples from mechanical engineering field.

UNIT-3 Fourier Transforms [11 hrs]

Infinite Fourier transforms, Fourier sine and cosine transforms. Inverse Fourier transforms. Applications to mechanical engineering problems.

UNIT-4 Numerical Solution of Differential Equations [11 hrs]

Numerical solution of simultaneous first order ODE -Picard's and Runge-Kutta method of fourth order. Numerical solution of second order ordinary differential equations - Picards method, Runge-Kutta method and Milne's method. Numerical solutions of PDE- Finite difference approximations to derivatives, Numerical solution of two –dimensional Laplace equation, one-dimensional Heat and Wave Equations.

Text books:

1. B.S. Grewal, "**Higher Engineering Mathematics**", Khanna Publishers, 43nd edition, 2015.
2. Erwin Kreyszig, "**Advanced Engineering Mathematics**", Wiley Publications, 10th edition, 2015.

Reference Books:

1. B.V. Ramana, "**Higher Engineering Mathematics**", Tata McGraw Hill Publications, 19th edition, 2013.
2. R.K.Jain and S.R.K.Iyengar, "**Advanced Engineering Mathematics**", Narosa Publishing House,5th edition, 2014.

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
B18ME4020	**Kinematics of Machines**	HC	4	4	0	4	4
Prerequisites: Basic Mathematics, Engineering Mechanics		Internal Assessment			Semester End Exam		
		40 Marks			60 Marks		

Course Objectives:

1. To teach the students to gain the Knowledge of Mechanisms, and their mobility.
2. To analyze velocity and acceleration for different mechanisms
3. To understand the fundamentals of gear teeth, types of gear, gear mesh and its arrangements.
4. To teach the kinematic analysis of cam- follower motion.

Course Outcomes:

By the end of the course the student shall be able to

1. Differentiate between a machine and mechanism, its degrees of freedom, possible inversions and classify mechanism with lower pair based on applications.
2. Determine the velocity and acceleration of simple mechanisms.
3. Classify different types of gears and evaluation of gear arrangements
4. Classify and draw types of cams and follower based on motion.

Course Content:

UNIT-1 Simple Mechanisms [11hrs]

Introduction: Links-types, Kinematics pairs-classification, Constraints-types, Degrees of freedom of planar mechanism, Grubler's equation, linkage mechanisms, inversions of four bar chain, slider crank chain and double slider crank chain.

Mechanisms with Lower Pairs: Pantograph, Exact straight line motion mechanisms-Peaucellier's, Hart and Scott Russell mechanisms, Approximate straight line motion mechanisms–Grass-Hopper, Watt and Tchebicheff mechanisms, Hooke's joint, Davis gear mechanism. Analysis of Ackermann steering gear mechanisms.

UNIT-2 Velocity and Acceleration in Mechanisms [12 hrs]

Velocity in Mechanisms: Velocity of point in mechanism, Velocities in four bar mechanism and slider crank mechanism, relative velocity method, Instantaneous centre method, Types & location of instantaneous centers, Kennedy's theorem, Velocities of slider crank mechanism.

Acceleration in Mechanisms: Introduction to Acceleration of a point on a link, Acceleration diagram for four bar and single slider mechanism, concept of coriolis component of acceleration , Crank and slotted lever mechanism, Klein's construction for Slider Crank mechanism.

UNIT -3 Gears and Gear Trains [11 hrs]

Gears : Classification & terminology, law of gearing, tooth forms & comparisons, Systems of gear teeth, Analysis of spur gears, Length of path of contact, contact ratio, interference & under cutting in involute gear teeth, minimum number of teeth on gear and pinion to avoid interference, Numerical

Gear Trains: Simple, compound, reverted and , Epicyclic gear train, Numerical.

UNIT -4 Cams [11 hrs]

Cams and Followers - Classification & terminology, Cam profile by graphical methods with knife edge and roller follower for uniform velocity, uniform acceleration and retardation , simple harmonic and parabolic motion

Text Books:

1. Thomas Bevan **Theory of Machines** -,3rd edition,CBS publications.
2. Shigley, **Theory of Machines and Mechanisms**- 3rd edition Mc Graw Hill Book company
3. R S Khurmi & J K Gupta, **Theory of Machines** ,5th edition, S. Chand publications
4. R. K. Bansal , **Theory of Machines** –6th edition, Laxmi Publications

Reference Books:

1. Ghosh & Mallik **Theory of Machines and Mechanisms**- 3rdedition, East west press
2. S.S. Rattan, **Theory of Machines**- 3rd edition, 2013,TMH publications
3. Dr. Sadhu Singh **Kinematics of Machines**-, 2nd edition, Pearson Publication

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
B18ME4030	**Applied Thermodynamics**	HC	3	1	0	4	5
Prerequisites: Engineering Thermodynamics, Applied Chemistry		Internal Assessment			Semester End Exam		
		40 Marks			60 Marks		

Course Objectives:

1. To describe the basic principles of applied thermodynamics, to give students a feel for how thermodynamics is applied in engineering practice.
2. To develop an intuitive understanding of thermodynamics by emphasizing the physics and physical arguments.
3. To read the basics of combustion, air fuel ratio required and their Practical applications.
4. To discuss the concept of refrigeration and its importance in practical applications.
5. To teach students about properties of moist air and process related to moist air
6. To generalize the application of P-H diagram in vapor compression refrigeration process.

Course Outcomes:

By the end of the course the students shall be able to

1. Define the basic concepts and definitions used in applied thermodynamics.
2. Explain and calculate the performance characteristics of reciprocating air compressor.
3. Learn and describe necessity of applied thermodynamics and basics of steam nozzle and steam turbine Engines.
4. Explain the different types of refrigerating systems and Apply the knowledge of P-H chart
5. Apply the various methods to improve the efficiency of Vapour power cycle
6. Define the basic concepts of psychrometric properties of moist air

Course Content:

UNIT-1 Combustion Thermodynamics and Gas Power Cycles [11hrs]

Theoretical (Stoichiometric) air and excess air for combustion of fuels, Mass balance, actual combustion, exhaust gas analysis, A/ F ratio, energy balance for a chemical reaction, enthalpy of formation, enthalpy and internal energy of combustion, combustion efficiency, adiabatic flame temperature. Assumptions during analysis of air standard cycles, Air standard cycles: Carnot, Otto, Diesel, Dual and Stirlling cycles, Representation of cycles on P-V and T-S diagrams; description, efficiencies and Discussion on mean effective pressures, comparison of Otto, Diesel and Dual combustion cycles, numerical.

UNIT-2 Evaluation of IC Engine and Vapour Power Cycles [11 hrs]

Evaluation of Performance parameters-Mean effective pressure, Indicated Power, Brake power, Fuel consumption, Specific fuel consumptions, different efficiencies, Rope brake dynamometer, heat balance sheet, Determination of frictional Power- Willan's line method, Morse Test, and Motoring test, numerical. Carnot vapor cycle and its limitations. Simple Rankine cycle- description, T-S diagram, analysis for performance. Comparison of Carnot and Rankine cycles. Effects of operating conditions on Rankine cycle performance, Actual vapour power cycles, practical regenerative Rankine cycles, and open feed water heaters. Reheat Rankine cycle, numerical.

UNIT-3 Gas Turbine and Air Compressor [11 hrs]

Classification of gas turbines, Joule's cycle, thermal efficiency, optimum pressure ratio, analysis of Joule's cycle used in gas turbines, Actual Joule's cycle, methods to improve thermal efficiency(no numerical), jet propulsion and rocket propulsion, Numerical.

Operation of a single stage reciprocating compressors, Work input, Effect of Clearance volume and Volumetric efficiency. Adiabatic, Isothermal and Mechanical efficiencies. Multi-stage compressor, Inter-cooling, Optimum intermediate pressure for minimum work input.

UNIT-4 Refrigeration and Air Conditioning [12 hrs]

Air cycle refrigeration- reversed Carnot cycle, reversed Brayton cycle, Vapour compression refrigeration system; description, analysis, refrigerating effect. Capacity, power required, units of refrigeration, COP, Refrigerants and their desirable properties, Vapour absorption refrigeration system. Numerical on refrigeration. Study of P-h chart. Definition, psychometric properties-dry bulb temperature, wet bulb temperature, dew point temperature, partial pressures, specific, absolute and relative humidity, degree of saturation, enthalpy of moist air, Psychometric Chart ,psychometric processes, summer and winter air conditioning, Numerical.

Text Books:

1 Nag P.K. **Basic & Applied Thermodynamics**. Tata McGraw Hill Pub. Co. 2002.
2 Yunus A. Cenegal and Michael A. Boles, "**Thermodynamics -An Engineering Approach**", Tata McGraw-Hill.2012
3 Rajput R.K, **Thermal Engineering**. Lakshmi publications. (2016)

Reference Books:

1. C. P. Arora, (2005) **Thermodynamics**, Tata McGraw-Hill Publishing Company Ltd.
2. G J Van Wylen and R E Sonntag, "**Fundamental of Classical Thermodynamics",** Wiley Eastern.1st edition,2002
3. Mahesh M Rathore, **Thermal Engineering**, Tata McGraw-Hill publications.

Soft Core -1

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
B18ME4041	**Internal Combustion Engines**	SC	3	0	0	3	3
Prerequisites: Engineering Thermodynamics, Applied Thermodynamics		Internal Assessment			Semester End Exam		
		40 Marks			60 Marks		

Course Objectives:

1 To describe the working of spark ignition and compression ignition engines.
2. To know the phenomenon of combustion of SI and CI engines.
3. To teach students about the usage of alternate fuels for IC engines.
4. To enhance the understanding of students in engine emissions, pollution and their control.

5. To introduce students to the recent trends in IC Engines like stratification, multi-point injection, plasma ignition etc,.

Course Outcomes:

By the end of the course the students shall be able to:

1. Determine performance and combustion characteristics of SI and CI engines.
2. Identify the usage of alternate fuels and power plants for automobiles.
3. Determine emissions from SI and CI engines.
4. Demonstrate the ability to enhance the efficiency and performance of IC engines.
5. Explain various types fuels used in engines.

Course Content:

UNIT -1: Spark Ignition Engines and Combustion in SI engine [11 hrs]

Spark Ignition Engines: Introduction , Spark ignition Engine mixture requirements - Feedback Control Carburetors –Properties of Fuel - Injection systems –Mono point and Multipoint injection – Gasoline Direct Injection cooling system in SI Engine.

Combustion in SI engine: Stages of combustion ,Ignition Lag-Flame propagation- Normal and Abnormal combustion- Detonation or knock-Factors affecting knock , Combustion Chambers types and designs, cooling system in CI Engine.

UNIT -2: Compression Ignition Engines and Characteristics of Fuel [11 hrs]

Compression Ignition Engines: States of combustion in C.I. Engine , Diesel knock, methods of controlling diesel knock, Direct and indirect injection systems, Combustion chambers type and design.

Characteristics of Fuel: Fuel sprays behavior - spray structure , Air motion ,Hybrid system, Turbo charging ,Supercharging, objectives, super charging of CI Engine ,rating of fuels -cetane number and octane number.

Self-Study- Triple spark engine, stratified charge engine.

UNIT -3: Engine Emissions and their Control [11 hrs]

Pollutant - Sources and types , formation of NOx , Hydrocarbon Emission Mechanism , Carbon Monoxide Formation , Particulate emissions ,Methods of controlling Emissions- Catalytic converters and Particulate Traps-Selective Catalytic Reduction(SCR)-Diesel Oxidation Catalyst(DOC)-Methods of measurements . Diesel smoke and its control- Diesel odor and its control.

Self-Study- Emission Norms ,working of Exhaust Gas Recirculation

UNIT -4: Alternate Fuels and Recent Trends in IC Engines [12 hrs]

Alcohol, Hydrogen , Natural Gas , Liquefied Petroleum Gas, Biogas, Bio diesel- Properties, Suitability Merits and Demerits as fuels, Engine Modifications.

LHR Engines-Learn Burn Engines Stratified charge spark ignition engine – Homogeneous charge compression Ignition, Plasma Ignition, Electric/Hybrid Vehicles, Electronic Engine Management.

Self-Study- preparation of Biodiesel by different methods and its properties.

Text Books

1 R.B.Mathur and R.P.Sharma, (2002), **Internal Combustion Engines**., Dhanpat Rai & Sons
2. Ganesan V. **Internal Combustion Engines**, Tata McGraw Hill. (1999),

Reference Books

1. Colin R.Feriguson, and Allan.T.Kirkpatrik, **I.C.engines Applied Thermo sciences** (2000),
2. John B. Heywood, (2000), **Internal Combustion Engine Fundamentals**, McGraw Hill.
3. Rowland S.Benson and N.D.White house, (2000) **Internal combustion Engines, Vol. I and II**, Pergamon Press.
4. Richard.L.Bechfold, **Alternative Fuels Guide Book**, SAE International Warrendale,1997.
5. "**Alcohols as motor fuels progress in technology**" - Series No.19 - SAE Publication

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
B18ME4042	**Advanced Materials**	SC	3	0	0	3	3
Prerequisites: Material Science, Manufacturing Technology		Internal Assessment			Semester End Exam		
		40 Marks			60 Marks		

Course Objectives:

1. An understanding of the principles, capabilities, limitations and applications of commonly used advanced materials.
2. To emphasize the significance of materials selection in the Composite materials.
3. To comprehend the importance of shape memory and super alloys.
4. To get familiarize with the new concepts of Nano Science and Technology.

Course Outcomes:

By the end of the course students shell be able to:

1. Select appropriate advanced materials for the specific applications.
2. Characterize the different composite materials and Smart Materials.
3. Select the shape memory and super alloys for engineering practice.
4. Choose appropriate Nano materials for different types of applications.

Course Content:

UNIT -1: Metals and Alloys [11 hrs]

Metals and Alloys: Classification and characteristics: Metals, Ceramics, Polymers and composites. Ferrous Alloys: properties, structure.

Non Ferrous alloys: Alloys of copper, Aluminum, nickel, magnesium, titanium, lead, tin, Zinc - composition, heat treatment, structure, properties and application.

UNIT -2: Composite and Smart Materials [11 hrs]

Composites: Definition, classification and characteristics of composite materials , Metal Matrix Composites, Polymer matrix composites and Ceramic matrix Composites and its Applications

Smart Materials: Review of Composite Materials, Definition and classification of Smart Materials, Smart Materials (Physical Properties) Piezoelectric Materials, Electrostrictive Materials, Magnetostrictive Materials, and Self Healing Polymers.

UNIT -3: Super Alloys and Shape Memory Alloys [11 hrs]

Ni-based, Fe-based, Co-based super alloys, and properties and its applications, Cu-based and NiTi shape memory alloys properties and its applications. High temperature alloys: Classification of Titanium alloys, properties and applications, heat treatment and machining of Ti alloys

UNIT -4: Nano science and Nanotechnology [12 hrs]

Basic concepts of Nanoscience and Nanotechnology, Carbon nano tubes – Material processing by chemical vapor deposition and physical vapor deposition – Principle of SEM, TEM, AFM, Scanning near-field optical microscopy (SNOM), Potential uses of nanomaterials in electronics, robotics, computers, sensors, sports equipment, mobile electronic devices, vehicles and transportation – Medical applications of nano materials.

Text Books

1. William D. Callister Jr. **Materials Science & Engineering -an introduction**, 4th edition. John Wiley & Sons.
2. R. A. Flinn & P. K. Trojan, **Engg. Materials & their applications**-4th edition, Jaico Publishing House.
3. M. V. Gandhi and B. So Thompson **Smart Materials and Structures**- - Chapman & Hall, London; New York – 1992.
4. Thiruvadigal,J.D., Ponnusamy,S..Sudha.D. and Krishnamohan M.,"**Materials Sciences**", Vibrant Publication, Chennai, 2013.
5. Rajendran.V, "**Materials Science**",Tata McGraw- Hill,New Delhi,2011
6. R. E. Smallman, A.H.W. Ngan, "**Physical Metallurgy and Advanced Materials**" Butterworth-Heinemann Publications, Berlington MA 01803

Reference Books

1. James.F.Shackleford **Introduction to Material Science and Engineering**- Mc Millan, NY - 7th edition.
2. Chawla K.K, **Composite Materials-Science and Engineering**- Springer - Verlag, Newyork-2nd edition, 1998.
3. Mick Wilson, Kamali Kannangara, **Nanotechnology – Basic Science and Emerging Technologies** Overseas Press India Private Limited, First Indian Edition 2005.

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
B18ME4043	**Plastic Engineering**	SC	3	0	0	3	3
Prerequisites: Chemistry		Internal Assessment			Semester End Exam		
		40 Marks			60 Marks		

Course Objectives:

1 To impart the knowledge about the plastic engineering.
2. To enhance the knowledge of polymers.
3. To analyze the importance of processing of polymers.
4. To study different techniques involved in polymer testing.

Course Outcomes:

By the end of the course the Student shall be able to

1. Explain polymers and classification of polymers.
2. Explain various methods for processing of polymers.
3. Define polymer properties.
4. Explain the various processes on polymers.

Course Content:

UNIT -1: Introduction to Polymers and Classification [11 hrs]

Basics of Polymers: Historical developments in polymeric materials, Basic raw materials for polymers, Basic concepts Macromolecules, Monomers, Oligomers, Telomers, polymer, repeating unites. Functionality concept and determination of functional groups. Carothers equation and their application. Introduction to types of polymerization, emulsion, solution, Bulk with typical examples.

Types of polymers: Thermoplastic/Thermoset, Addition/Condensation, Natural/Synthetic, Crystalline/Amorphous, Step growth/ Chain growth, Homochain/ Hetero chain, Confirmation: Homo and Copolymers, Configuration Cis/Trans; Tacticity, Branched/Cross linked, Classification based on end use, Commodity/Specialty. Polymer degradation and polymer stabilization.

UNIT -2: Polymer Processing and Polymer Testing [11 hrs]

Polymer processing: Compression molding, transfer molding, injection molding, blow molding, reaction injection molding, extrusion, pultrusion, calendaring, rotational molding, thermoforming, rubber processing in two-roll mill, internal mixer.

Polymer Testing: Mechanical-static and dynamic tensile, flexural, compressive, abrasion, endurance, fatigue, hardness, tear, resilience, impact, toughness. Conductivity-thermal and electrical, dielectric constant, dissipation factor, power factor, electric resistance, surface resistivity, volume resistivity, swelling, ageing resistance, environmental stress cracking resistance.

UNIT -3: Mechanical Properties and Polymer Product Design [11 hrs]

Mechanical Properties: Stress-strain relationship, Tensile tests, Flexural properties, Compressive properties, Impact properties, Shear strength, Abrasion, Fatigue resistance, creep and stress relaxation, Hardness Tests. Burst strength test.

Product Design: Component design, Control over product stiffness composite shapes and structures Design of thermoplastics and thermosetting type of polymers under static and dynamic loads, Design of sandwich panels and reinforced plastics parts PVC piping: Raw materials, pipe design, specification and test procedure, manufacturing process.

UNIT -4: Mechanical Operation [12 hrs]

Particulate Solids and Sorting: Properties of solids, characterization of solid particles, particle size analysis. Gravity settling, classifier, hydraulic jig, cyclones.

Size Reduction: Principles and laws of crushing, construction and working of equipments like jaw crusher, pulverizer, ball mill. Screening and screen efficiency, open and closed circuit grinding.

Sedimentation and Filtration: Free and hindered settling, thickeners and settlers, Flocculation. Filter media, filter aids, plate and frame press, rotary drum filter and filter leaf, Centrifugal filtration.

Text Books

1. P. Ghosh **Polymer Science & Technology of Plastics & Rubbers** Tata McGraw Hill 2 nd edition.
2. Joel R. Fried **Polymer Science & Technology** Prentice Hall of India Pvt. Ltd. 3 rd edition.
3. F.W. Billmeyer **Text Book of Polymer Science** Wiley Inter science 3rd edition.

Reference Books

1. Robert A. Malloy Hanser Pub., **Plastic Part Design for Injection Moulding** Munich Vienna NY, 1994.
2. H. Belofsky SPE, **Product Design and Process Engineering** Hanser Publication, Munich Vienna NY, 1995.
3. S.Levy & J.H.Dubois **Plastic Product Design Engineering Hand Book** Van Nostrand Reinhold, New York, 1977

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
B18ME4044	**Principles of Management**	SC	3	0	0	3	3
Prerequisites: None		Internal Assessment			Semester End Exam		
		40 Marks			60 Marks		

Course Objective

1. The course is to provide an opportunity to gain the knowledge about management its evolution, functions and theories.
2. To impart the knowledge in the field of entrepreneurship, entrepreneurial process and management of resources
3. To provide the knowledge to start up small scale industries. Learn various supports (consultancy & finance) from government, institutes & others agencies.
4. To learn the effect of WTO/GATT and government policies (industrial policy regulations) on small scale industries and MSMEs.
5. To learn the basics about project preparation process and its analysis.

Course Outcomes:

By the end of the course student shall be able to

1. Define the management, MBO, MBE.
2. Elaborate concept of Entrepreneurship.
3. Explain the steps in establishing SSI.
4. Explore various supporting to SSI.

Course Content:

UNIT -1: Management [11 hrs]

Meaning, nature and characteristics of management. Scope & functional areas of management. Management as a science, art or profession, Management and Administration, role of management, Levels of management, early management approaches and modern management approaches. Management by Objectives (MBO) - Principles and Steps - Advantages and disadvantages - Management by Exception (MBE) - Strategic management – SWOT analysis, Management and Society: External Environment, Social responsibility and Ethics.

UNIT -2: Planning, Organizing and Staffing [11hrs]

Planning-Nature, Importance and purpose of planning process, Objectives, types of plans (meaning only) Steps in planning, Hierarchy of plans.

Organizing and Staffing-Nature and purpose of organization, Principles of organization, Types of organization, departmentation, Committees – centralization V/s decentralization of authority and responsibility, Importance of staffing, Process of selection and recruitment.

UNIT -3: Directing and Controlling [11 hrs]

Meaning and nature of directing, leadership styles, Motivation theories (Maslow, Herzberg, McGregor theory), Communication- meaning and importance, Co-ordination- meaning and

importance, techniques of coordination, definition and steps in controlling, Essentials of a sound control system, methods of establishing control.

UNIT -4: Entrepreneurship and Small Scale Industry [12 hrs]

Entrepreneurship-Meaning of entrepreneur, evaluation of the concept, function of an entrepreneur, types of entrepreneur, entrepreneurship, concept of entrepreneurship, Stages in entrepreneurial process, Role of entrepreneurs in economic development.

Small Scale Industry: Definition, characteristics, steps to start an SSI, different policies of SSI, Impact of liberalization, privatization, globalization on SSI, State government institutions & central government institutions, TECKSOK, KIADB, KSSIDC, KSIMC, DIC, Single window Agency, SISI, NSIC, SIDBI, KSFC.

Text Books:

1. Harold Koontz, Heinz Weihrich, **Essentials of Management** – Fifth Edition, Tata McGraw Hill.
2. PC Tripati, P N Reddy, **Principles of Management** –Tata Mc Graw Hill, 3rd edition 2005.
3. Vasant Desai **Dynamics of Entrepreneurial Development & Management** Himalaya Publishing House, 2nd edition 2006.

Reference Books:

1. Robert Lusier– **Management Fundamentals, Concepts, Application, Skill Development**, 1st edition. 2006
2. Poornima M Charanthmath, **Entrepreneurship Development–small Business Enterprises** Pearson Education –3rd edition 2005
3. Stephen Robbins **Management** – Pearson Education / PHI – 17th Edition, 2003.
4. S S Khanka **Entrepreneurship Development**, S Chand & Co, 4th edition 2005

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
B18ME4045	**Object Oriented Programming with C++**	SC	2	0	1	3	4
Prerequisites: Basics of 'C'		Internal Assessment			Semester End Exam		
		40 Marks			60 Marks		

Course Objective

1. To introduce object oriented programming concepts and implement them in C++.
2. Differentiate procedure oriented and object-oriented concepts.

3. Presents the concept of Inheritance so that learner understands the need of inheritance.
4. To know the importance of data hiding in object oriented programming

Course Outcomes:

By the end of the course student shall be able to

1. Describe the differences between procedure oriented programming and object oriented programming.
2. Describe a class and object.
3. Describe how to access private, public and protected members of a class.
4. Define member functions inside the class definition and outside the class definition.
5. Design and use friend functions and friend classes.
6. Apply inheritance to build class hierarchies.

Course Content:

UNIT -1: Introduction [11 hrs]

Procedure Languages, definition of OOP, Basic concept of OOP, Object, Class, Data Abstraction, Data Encapsulation, Data Hiding, Reusability, Inheritance, Polymorphism, Overloading, Dynamic binding: Basic data types-The iostream class, C++ Comments, C++ Keywords, Variable declaration, The Const Qualifier. Manipulators, The scope resolution operator, new & delete operators. Functions: pass by value; pass by reference, inline function, overloaded functions, default arguments, return statements, function overloading.

UNIT -2: Objects and Classes [12hrs]

Objects & Classes: Classes & Objects, Class Declaration, Class members, Data Members, Member functions, Class member visibility, private, public, protected. Constructors and Types of Constructors, Overloaded Constructor, Objects as arguments, returning objects from functions, Destructors, Array of objects. Friend function; Friends for functional notation, friend classes, the pointer; Accessing Member Data with this, using this for returning values.

UNIT -3: Inheritance [11 hrs]

Inheritance: Derived Class & Base Class: Specifying the Derived class accessing Base class members, the protected access specifier, Types of inheritance: Single inheritance, Multiple inheritance, Multilevel inheritance, Hybrid inheritance, public and private inheritance, Overriding member functions.

UNIT -4: Operator Overloading [11 hrs]

Operator Overloading: Overloading unary operator: Operator Keyword, Operator arguments, Operator return. Overloading binary operator: arithmetic operators, comparison operator.Virtual functions: Normal member function accessed with pointers, Virtual member functions accessed with pointers, Dynamic binding, pure virtual functions.

Text Books:

1. Lafore Robert, "**Object Oriented Programming in Turbo C++**", Galgotia Publications, 2012. (Unit I)
2. E. Balaguruswamy: **Object Oriented Programming with C++**, Tata McGraw Hill Publications, 2011.(Unit II,III &IV)

Reference Books:

1. Herbert Schildt, "**C++: The Complete Reference**" Osborne McGraw-Hill, Third edition, 1998.
2. P. B. Kotur, "**Object Oriented Programming with C++**" Eigth Edition.

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
B18ME4150	**Material Science and Metallurgy**	HC	3	0	0	3	3

Prerequisites: Physics	Internal Assessment	Semester End Exam
	40 Marks	60 Marks

Course Objectives:

1. To provide the basic knowledge required to explore the materials science and engineering.
6. To enhance the knowledge of the structure of materials which includes crystallography, microstructure, defects, and phase diagrams.
7. To develop the knowledge about the heat treatment process required for the metals.
8. To incorporate the knowledge in various class of materials and their applications.

Course Outcomes:

By the end of the course student shall be able to

1. Recognize the classification of materials based on atomic arrangement and
2. Behavior of materials in elastic and plastic regions.
3. Illustrate the mechanism of solidification for various alloys.
4. Identify the different phases of iron and apply required heat treatment process for the industrial purposes.
9. Enumerate the knowledge on different class of materials and their failures.

Course Content:

UNIT-1: Crystalline Structure and Crystal Defects [11 hrs]

Introduction, Seven Systems and fourteen lattices, Metal structures, Ceramic Structures, Polymeric structures, Semiconductor structures, Lattice positions, Directions and planes.The solid solution-chemical imperfection, Point defects-zero dimensional imperfections, Linear defects or dislocation-one dimensional imperfections, Planar defects-Two dimensional imperfections, Nanocrystalline solids-Three dimensional imperfections. Introduction to Microscopy, XRD & SEM.

UNIT–2: Solidification and Phase Diagrams [11 hrs]

Mechanism of solidification, homogeneous and heterogeneous solidification, Hume Rothary rules substitution and interstitial solid solutions. Construction of phase diagram for two component systems, application of Gibbs phase rule. Construction of phase equilibrium diagram involving complete and partial solid solubility, application of lever rule. (with numerical), Iron carbon equilibrium diagram and invariant reactions.

UNIT-3: Heat Treatment of Metals and Alloys [11 hrs]

Heat treatment of metals: Annealing method and its types. Normalizing, hardening, tempering, martempering, austempering. Hardenability, surface hardening methods like carburizing, cyaniding, nitriding, flame hardening and induction hardening, age hardening of aluminium-copper alloys- Methods with applications

UNIT-4: Mechanical Behavior of Materials [12 hrs]

Stress – strain diagram for ductile and brittle materials, elastic and plastic deformation, mechanical properties in elastic and plastic region, linear and non-linear properties (no numerical)

Creep – Phenomenon, stages of creep and creep properties. Fatigue- Types of fatigue loads, fatigue properties, Fatigue test and S- N curves.

Fracture: Mechanism of fracture, ductile and brittle fracture, Griffith's theory of fracture (only derivation), ductile to brittle transition.

Text Books:

1. James F Shackleford.,& Madanapalli K Muralidhara, **Material science for Engineers,** Sixth edition, Pearson Publications - 2007
2. Smith, **Foundations of Materials Science and Engineering,** 4th Edition McGraw Hill, 2009.

Reference Books:

6. Alan Cottrell **An Introduction to Metallurgy** Universities Press India Oriental Longman Pvt. Ltd., 1974.
7. W.C.Richards **Engineering Materials Science**, PHI, 1965
8. V.Raghavan **Materials Science and Engineering**, , PHI, 2002
9. William D. Callister Jr., **Materials Science and Engineering**, John Wiley & Sons. Inc, 5th Edition, 2001.
10. Traugott Fischer, **Materials Science for Engineering Studies,** 2009. Elsevier Inc

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
B18ME4160	**Computer Aided Machine Drawing**	HC	1	0	2	3	5
Prerequisites: Computer Aided Engineering Drawing		Internal Assessment		Semester End Exam			
		40 Marks		60 Marks			

Course Objectives:

6. Understand drawing and develop capacity to represent any matter/object with the help of picture.
7. Develop primary knowledge of working drawing.
8. Produce orthographic drawing of different machine parts.
9. Develop skill to produce assembly drawings.
10. To enable students to draw the assembly of various Mechanical machine components.

Course Outcomes:

By the end of the course student shall be able to

5. Analyze graphical knowledge.
6. Draw the machine elements like Fasteners and Joints.
7. Draw the machine elements Joints and Couplings.
8. Analyze and draw assembly drawings.

Course Content:

UNIT–1: Orthographic Views and Thread Forms [11 hrs]

Orthographic Views: Conversion of pictorial views into orthographic projections of simple machine parts with or without section. (Bureau of Indian Standards conventions are to be followed for the drawings).
Thread Forms: Thread terminology, sectional views of threads: ISO Metric (Internal & External) BSW (Internal & External) square and Acme. Sellers thread, American Standard thread.

UNIT-2: Fasteners and Joints [11 hrs]

Fasteners: Orthographic projection of Hexagonal headed bolt and nut with washer (assembly), square headed bolt and nut with washer (assembly).
Joints: Single and double riveted lap joints, butt joints with single/double cover straps (Chain and Zigzag, using snap head rivets).

UNIT -3: Joints and Couplings [11 hrs]

Cotter joint (Single Cotter) (socket and spigot), knuckle joint (pin joint) for two rods,
Couplings: Split Muff coupling, Protected and Unprotected type flanged coupling, Basics of GD&T.

UNIT–4: Assembly Drawing [12 hrs]

Screw jack (Bottle Type)(Demo), Machine vice. I.C. Engine connecting rod, Plummer block (Pedestal Bearing), Feed Check Value, Rams Bottom safety Valve, Tailstock of lathe, Lathe Square tool post.

Text Books:

3. N D Bhat and V.M. Panchal, **Machine Drawing** Published by Charotar Publishing house-1999
4. Robert C Juvinall and Kurt M Marshek, "**Machine Component** Design" Wiley publications.

Reference Books:

4. K R Gopalakrishna **"Machine Drawing"** – Subhash publishers, Bangalore.
5. Sham Tickoo, **"CAD for Engineers and Designers",** Dream Tech 2005.
6. N Siddeshwar, P.Kanniah, V.V.S Sastri, "**Machine Drawing**" Published by TATA McGraw Hill,2006

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
B18ME4170	**Materials Testing and Characterization Lab**	HC	0	0	2	2	3

Prerequisites: Material Science, Mechanics of Materials	Internal Assessment	Semester End Exam
	20 Marks	30 Marks

Course Objectives:

7. To prepare the specimen for metallographic examination
8. To study the wear characteristics of the given specimen
9. To study the tensile , compressive and shear prosperities of metals and non metals
10. To evaluate Brineel, Vicker's and Rockwell's hardness of the materials
11. To find impact strength of the given material
12. To find the endurance limit of the material

Course Out comes:

By the end of the course the student shall be able to

6. Identify the type of material based on the microstructure using optical microscope.
7. Evaluate the wear properties.
8. Determine the defects in the given specimen using Ultrasonic flaw detection, Magnetic crack detection and Dye penetration test.
9. Determine tensile, compressive, torsional and bending properties of the given material using UTM.
10. Determine hardness of the given material & impact strength of the given material

List of Experiments

PART – A

4. Preparation of specimen for Metallograpic examination of different engineering materials. Identification of microstructures of plain carbon steel, tool steel, gray C.I, SG iron, Brass, Bronze & composites.
5. To study the wear characteristics of ferrous, non-ferrous and composite materials for different parameters.
6. Non-destructive test experiments like,
   a. Ultrasonic flaw detection
   b. Magnetic crack detection
   c. Dye penetration testing. To study the defects of Cast and Welded specimens

PART – B

7. Tensile, shear and compression tests of metallic and non metallic specimens using Universal Testing Machine
8. Torsion Test
9. Bending Test on metallic and nonmetallic specimens.
10. Izod and Charpy Tests on M.S,& C.I Specimen.
11. Brinell, Rockwell and Vickers's Hardness test.
12. Fatigue Test.

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
B18ME4180	**Casting and Forging Lab**	HC	0	0	2	2	3
Prerequisites: Manufacturing Technology		Internal Assessment			Semester End Exam		
		20 Marks			30 Marks		

Course Objectives:

6. The course will introduce desirable properties of molding sand and establish its relevance in preparing the sand mold.
7. To introduce the experimental procedure in determining the GFN, Permeability, Strength of mold, moisture & clay content in sand sample, core hardness & mold hardness.
8. To bring in the effect of clay & water content on the various properties of molding sand.
9. To give students hands on practice in preparing the sand moulds (Cope & Drag box) using single piece, split pattern and without using pattern.
10. To give students hands on practice in preparing forging models using open -hearth furnace by performing upsetting, drawing & bending operation.

Course Out comes:

By the end of the course the student shell be able to

9. Describe general properties of molding sand.
10. Illustrate the influence of Grain fineness of the silica sand used in the preparation of the mold
11. Determine the compression, shear, tensile strength & permeability of a molding sand for different proportion of clay.
12. Determine the percentage of clay & moisture content for a given sand sample
13. Identify the different tools used in foundry & Forging practice with their uses
14. List the different stages involved in preparing the sand mold box & forged model
15. Create the sand mold cavity using cope & drag box with pattern or without pattern
16. Demonstrate the upsetting, drawing & bending operation in preparing the forged model

List of Experiments

PART – A

1. Testing of Moulding Sand and Core Sand:

Preparation of sand specimens and conduction of the following tests:

f. Compression, Shear and Tensile tests on Universal Sand Testing Machine.
g. Permeability test
h. Core hardness & Mould hardness tests.
i. Sieve Analysis to find Grain Fineness number of Base Sand
j. Clay content determination in Base Sand

PART – B

2. Foundry Practice

d. Use of foundry tools and other equipments.
e. Preparation of moulds using two moulding boxes using patterns or without patterns. (Single piece Split pattern, and hand cut)
f. Preparation of one casting (Aluminum or cast iron-Demonstration only)

PART – C

3. Forging Operations:

c. Calculation of length of the raw material required to do the model.
d. Preparing minimum three forged models involving upsetting, drawing and bending operations.

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
B18ME4250	**Mechanical Measurements and Metrology**	HC	3	0	0	3	3
Prerequisites: Basic knowledge on physics		Internal Assessment			Semester End Exam		
		40 Marks			60 Marks		

Course Objectives:

5. To impart the knowledge of importance of standards & conversion.
6. To introduce the fundamental concepts & derive the relations for the design of gauges, types of gauges, concepts involving comparators, angular measurements,

7. To elaborate the fundamental methods of measurement, concept of transducer & terminating devices, exposure to the errors, classification & remedies.
8. To explore the various aspects regarding the strain & temperature measurement

Course Outcomes:

By the end of the course students shall be able to

1. Explain the need, history for the development of new concepts of metrology and measurement,record and interpret the data.
2. Demonstrate the fundamentals of standards, comparison between the standards and unknown quantity.
3. Explain the concepts of error and accuracy.
4. Apply the skills in measuring strain and temperature measurement..

Course Content:

UNIT-1: Basic of Metrology, Linear and Angular Measurement [11 hrs]

Objectives of metrology, role of standards, standards of length- International prototype meter, Imperial standard yard, wave length standard, subdivision of standards, line & end standard, calibration of end bars (numerical), Slip gauges, Wringing phenomenon, Numerical problems on building of slip gauges, Vernier bevel protractor, Angle gauges, Sine principle, Sine bar & Sine Centre.

UNIT-2: System of limits, Fits, Tolerance, Gauging and Comparators [11 hrs]

Need of limit system, Tolerance, Specification of tolerance in assembly, Accumulation tolerance & compound tolerance, principle of interchangeability & selective assembly, concept of limit of size & tolerance, Concept of fits, types of fits, shaft basis & hole basis system, geometric tolerance, tolerance grade, Numerical problem on limits and fits. Taylor's principle, introduction to comparators, need, characteristics, classification of comparators, Johanson Mikrokator, Zeisss ultra optimeter, Solex, LVDT.

UNIT-3: Temperature, Strain Measurement [11 hrs]

Introduction, resistance thermometer, thermocouple, law of thermocouple, materials used for construction, Pyrometer, optical pyrometer, radiation pyrometer,

Strain measurement, strain gauge, preparation & mounting of strain gauges, electrical strain gauge, backing & bonding materials.

UNIT-4: Advancement in Metrology [12 hrs]

Introduction, Direct method: Analytical balance, unequal arm balance, proving ring. Torque measurement: Mechanical, hydraulic dynamometer, Pressure measurements, principle, Bridgeman gauge, McLeod gauge, Pirani gauge. Introduction to advancement in metrology, lasers in metrology, advantages of lasers, laser scan micrometer, applications- straightness, alignment, ball bar test, Machine vision, basic concept of machine vision system, elements, applications.

Text Books:

5. Beckwith Marangoni and Lienhard, **Mechanical Measurements**, Pearson Education, 6th Ed., 2006.
6. R.K. Jain, **Engineering Metrology**, Khanna Publishers, 1994.
7. B.C Nakra **Instrumentation, Measurement & Analysis**, , K K Choudhary, 4th Edition, McGraw-Hill.
8. I.C.Gupta, **Engineering Metrology** Dhanpat rai publications.

Reference Books:

6. Bently, **Engineering Metrology and Measurements**, PearsonEducation.

7. Anand K. Bewoor & Vinay A. Kulkarni **Metrology & Measurement**, Tata McGraw.
8. N.V Raghavendra & L. Krishnamurthy, **Engineering Metrology and Measurements,** Oxford University Press.
9. Gupta I.C, **Engineering Metrology,** Dhanpat Rai Publications, Delhi.
10. R.K Jain **Mechanical Measurement**, Khanna Publishers. 1994

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
B18ME4260	**Theory of Metal Cutting and Machine Tools**	HC	3	0	0	3	3
Prerequisites: Manufacturing Technology		Internal Assessment			Semester End Exam		
		40 Marks			60 Marks		

Course Objectives:

1. To familiarize the student with tool nomenclature and cutting forces
2. To impart knowledge of mathematics on machining parameters for different machining processes, tool life and tool wear.
3. To acquire the knowledge about various machining processes for production of complex shaped components.
4. To predict a suitable super finishing process to produce the intricate components.

Course Outcomes:

By the end of the course student shell be able to

1. Analyze forces acting on the cutting tool in orthogonal and oblique cutting
2. Examine various process parameters to improve the cutting tool life
3. Ascertain the knowledge and need of super finishing process.
4. Identify the driving mechanism of different machine tools.

Course Content:

UNIT -1: Theory of Metal Cutting [11 hrs]

Introduction -Geometry of a single point cutting tool - Chip formation and types of chips–Orthogonal and oblique cutting – Merchant circle diagram for cutting forces - Shear angle in terms of chip thickness ratio and rake angle –Problems on shear angle - Machining variables – Factors affecting cutting tool life – Types of tool wear – Taylor's tool life equation – Problems on Taylor's tool life equation. Cutting tool materials of common use and their characteristics – Functions of cutting fluids – Types of cutting fluids – Heat generation in metal cutting and factors affecting heat generation – Measurement of tool tip temperature using tool work thermocouple technique.

UNIT -2: Lathe , Drilling and Shaping Machine [11 hrs]

Lathe: Working principle and specifications of lathe, Description of main components and lathe operations, Work holding devices. Constructional features of turret and capstan lathe. Automatic Lathe.

Drilling Machine-Principle of working, Classification, construction and working of Bench and Radial drilling machines, drilling operations, drill bit nomenclature, simple problems,

Shaping Machine: Introduction, types, construction and operations of horizontal shaper.

UNIT -3: Milling and Grinding Machine [11 hrs]

Milling: Principle of working, Classification of Milling machines, construction and working of Horizontal and vertical milling machines. Milling operations, methods of indexing simple and compound-problems on simple indexing.

Grinding: Working principle, constructional features of Cylindrical, Centerless and Surface grinding machines, Types of abrasives, Grinding operations- dressing, truing.

UNIT -4: Lapping, Honing and Broaching Machines [12 hrs]

Lapping – Principle of Lapping – Lapping methods – Advantages and limitations of lapping

Honing – principle of honing – Types of honing machines – Advantages, limitations and applications of honing.

Broaching – Principle of working – Details of a commonly used broach – construction and working of a horizontal broaching machine – Advantages, limitations and applications

Text Books:

1. Hajra choudhury, **Workshop Technology Vol-II**, Media Promoters & Publishers Pvt. Ltd. 2004
2. R.K Jain, **Production Technology**, Khanna Publications, 2003.
3. HMT, **Production Technology**, Tata McGraw Hill, 2001.
4. O.P Khanna,**Production Technology Vol-1**, Dhanpat Rai publications
5. Rajput,**Manufacturing Technology** Second edition, Laxmi Publications

Reference Books:

1. Amitabh Ghosh and Mallik **Manufacturing Science**, , affiliated East West Press, 2003
2. G. Boothroyd, **Fundamental of Metal Machining and Machine Tools**, McGraw-Hill, 2000.
3. G.C Sen & Bhattacharya **Principle of Machine Tools**, Tata Mcgraw hill, New Delhi
4. Kalpakjian, serope **Manufacturing Engineering and Technology**, Addison –wesley publishing co., New york
5. P.C Pandey & H.S Shan **Modern Machining Processes**:, T.M.H Company, New Delhi

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
B18ME4270	**Fluid Machinary Lab**	HC	0	0	2	2	3
Prerequisites: Fluid Mechanics		Internal Assessment			Semester End Exam		
		20 Marks			30 Marks		

Course Objectives:

1. To understand the various fluid flow measuring devices and find discharge.
2. To learn the testing procedure of the pumps and compressor.
3. To learn the procedure used to conduct performance test of the turbines.
4. To understand the performance characteristics of the fluid machineries.

Course Outcomes:

By the end of the course the student shell be able to

1. Identify the devices which are used for measurement of discharge.

2. Differentiate the pumps based on the working principle
3. Conduct the performance test on the turbine and compare the results in terms of performance curves.
4. Explain the working principle of the turbines and pumps.
5. Write the procedure involved in conducting the performance.

List of Experiments

1. Determination of friction factor and Reynold's number for the fluid flowing through pipes.
2. (Major losses)
3. Determination of friction Co-efficient of given pipe fittings and bends for fluid flowing through pipes. (Minor losses)
4. Determination of co-efficient of impact of jet on vanes.
5. Determination of co-efficient of discharge of given circular orifice.
6. Determination of co-efficient of discharge of given venturimeter.
7. Determination of co-efficient of discharge of given nozzle.
8. To calibrate of given Rotameter.
9. Performance test on Single stage Centrifugal pump to draw Main and Operating characteristic curves
10. Performance test on Multi- stage Centrifugal pump to draw Main and Operating characteristic curves
11. Performance test on Reciprocating pump to draw Operating characteristic curves
12. Performance test on Pelton turbine to draw Main and Operating characteristic curves
13. Performance test on Francis turbine to draw Main and Operating characteristic curves
14. Performance test on Kaplan turbine to draw Main and Operating characteristic curves

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
B18ME4280	**Metal Cutting and Machine Tool Lab**	HC	0	0	2	2	3
Prerequisites: Theory of Metal Cutting & Machine Tools		Internal Assessment			Semester End Exam		
		20 Marks			30 Marks		

Course Objectives:

1. To understand various operations carry out through various machines.
2. To provide knowledge about various machine tools.
3. To learn turning, milling and shaping operations.
4. To prepare the model as per the given dimensions

Course Out comes:

By the end of the course the student shall be able to

1. Identify the various operations require to prepare the model.

2. Select the suitable machine for a particular operation.
3. Prepare the specimen as per the given dimension for the given raw material.
4. Work in a manufacturing industry.

List of Experiments

PART-A

1. Preparation of various models on lathe involving Plain turning, Taper turning, Step turning, Thread cutting, Facing, Knurling, Drilling, Boring, Internal Thread cutting and Eccentric turning.

PART-B

2. Cutting of V Groove/ dovetail/Rectangular groove using a shaper.
3. Cutting of Gear Teeth Using Milling Machine

PART-C (Demo only)

1. Lathe tool dynometer
2. Drill tool dynometer
3. Effective diameter measurement-Two wire method
4. Taper measurement using Sine bar
5. Taper measurement using Sine center
6. Gear Tooth Vernier

FIFTH SEMESTER

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
B18ME5010	**Design of Machine Elements**	HC	3	1	0	4	5
Prerequisites: Mechanics of Materials		Internal Assessment			Semester End Exam		
		40 Marks			60 Marks		

Course Objectives:

1. To teach normal, shear and combined stress, codes and standards in relevance to mechanical engineering
2. To explain the concept of static strength, impact strength in machine elements
3. To incorporate fatigue strength, design procedure of threaded fasteners.
4. The design procedure of shafts, describe and analyze the application of keys ,cotter, knuckle and couplings
5. To introduce the concept of safe design of riveted, welded joints and power screws in industry applications

Course Outcomes:

By the end of the course student shall be able to

1. Describe and apply the knowledge of normal, shear, biaxial and tri axial stresses.
2. Identify the problems and apply the knowledge in finding appropriate solutions in fatigue stress and threaded fasteners.

3. Analyze the problems in design of shafts and identify, formulate, solve the different types of joints, keys and couplings in engineering problems.
4. Design and analyze the problem formulation of power screw and Riveted and Welded Joints.

Course Content

UNIT- 1 Introduction to Static and Impact Strength [12 hrs]

Introduction: Normal, Shear, biaxial and tri axial stresses, Stress tensor, Principal Stresses. Stress-Strain diagrams, Design considerations: Codes and Standards.

Design for Static & Impact Strength:

Static Strength: Static loads and factor of safety, Theories of failure: Maximum normal stress theory, Maximum shear stress theory, Maximum strain theory, Strain energy theory, and Distortion energy theory. Failure of brittle and ductile materials, Stress concentration, Determination of Stress concentration factor.

Impact Strength: Introduction, Impact stresses due to axial, bending and tensional loads.

UNIT- 2 Design for Fatigue and Temporary Fasteners [12 hrs]

Design For Fatigue Strength: Introduction- S-N Diagram, Low cycle fatigue, High cycle fatigue, Endurance limit, Modifying factors: size effect, surface effect, Stress concentration effects, Goodman and Soderberg relationship, stresses due to combined loading.

Threaded Fasteners: Stresses in threaded fasteners, Effect of initial tension, Design of threaded fasteners under static, dynamic and impact loads, Design of eccentrically loaded bolted joints.

UNIT- 3 Design of Shafts, Joints, Keys and Couplings [11 hrs]

Design of Shafts: Torsion of shafts, design for strength and rigidity with steady loading, ASME codes for power transmission shafting, shafts under fluctuating loads and combined loads.

Cotter and Knuckle Joints, Keys and Couplings: Design of Cotter and Knuckle joints, Keys: Types of keys, Design of keys, Couplings: Rigid and flexible couplings, Flange coupling.

UNIT- 4 Design of Permanent Fastening and Power Screws [10 hrs]

Riveted Joints– Types, rivet materials, failures of riveted joints, Joint Efficiency, Boiler Joints and Riveted Brackets.

Welded Joints – Types, Strength of butt and fillet welds, eccentrically loaded welded joints.

Power Screws: Mechanics of power screw, Stresses in power screws, efficiency and self-locking, Design of Power Screw, Design of Screw Jack.

Text Books:

1. Robert L. Norton, **Machine Design** Pearson Education Asia, 2001.
2. M. F. Spotts, T. E. Shoup, L. E.Hornberger, **Design of Machine Elements** S. R. Jayram and C. V. Venkatesh, Pearson Education, 2006.

Reference Books:

1. Hall, Holowenko, Laughlin **Machine Design** (Schaum's Outlines series) Adapted by S.K. Somani, Tata McGraw Hill Publishing Company Ltd., New Delhi, Special Indian Edition, 2008.

Design Data Data Hand Book:

1. **Design Data Hand Book**, K. Lingaiah, McGraw Hill, 2nd Ed.
2. **Data Hand Book,** K. Mahadevan and Balaveera Reddy, CBS Publication
3. **Design Data Hand Book**, H.G. Patil, I. K. International Publisher, 2010.

Course Code	Course Title	Course Type	L	T	P	C	Hrs. / Wk.
B18ME5020	**Turbo Machines**	HC	3	1	0	4	5
Prerequisites: Fluid Mechanics and Machinery, Engineering Thermodynamics,		Internal Assessment		Semester End Exam			
		40 Marks		60 Marks			

Course Objectives:

1. To provide a sound understanding of the comparison of positive displacement machine and Turbo machine.
2. To provide an understanding of thermal analysis in turbo machinery.
3. To provide an understanding of energy transfer in turbo machinery.
4. To provide knowledge about general analysis of radial flow turbo machines.
5. To provide knowledge of flow through nozzles.
6. To provide knowledge of design of steam turbines.

Course Outcomes:

By the end of the course the students shall be able to

1. Differentiate positive displacement machines and turbo machines.
2. Explain of Euler turbine equation and velocity triangles.
3. Draw velocity triangles of axial flow turbines and compressors.
4. Analyze hydraulic turbines and centrifugal pumps.

Course Content:

UNIT -1: Introduction and Thermodynamics of Fluid Flow [11hrs]

Introduction: Turbo machine; parts of a Turbo machine, classification, Comparison with positive displacement machine; Dimensionless parameters and their physical significance; Specific speed; Unit and specific quantities, model studies. Illustrative examples.

Thermodynamics of fluid flow: Static and Stagnation states- Incompressible fluids and perfect gases, overall isentropic efficiency, stage efficiency (their comparison) and polytrophic efficiency for both compression and expansion processes. Reheat factor for expansion process.

UNIT -2: Energy Transfer in Turbo Machine: [11hrs]

Euler Turbine equation; Alternate form of Euler turbine equation – components of energy transfer; Degree of reaction, Utilization factor, Vane efficiency; Relation between utilization factor and degree of reaction; Velocity triangles for different values of degree of reaction for axial flow turbines, Velocity triangles and condition for maximum utilization factor , Illustrative examples.

UNIT -3: General Analysis of Power Absorbing Turbo Machines and Steam Nozzles [11hrs]

General analysis of Power absorbing turbo machines: General analysis of axial flow Compressors and pumps , velocity triangles and general expression for degree of reaction, General analysis of Centrifugal flow Compressors and pumps , velocity triangles and general expression for degree of reaction , Theoretical head – capacity relationship, Types of centrifugal pump impeller. Illustrative examples.

Steam Nozzles: Type of Nozzles- Flow Through Nozzles- Condition for Maximum Discharge-Nozzle Efficiency- Super Saturated Flow in Nozzles- Relationship Between Area Velocity and Pressure in Nozzle Flow. Illustrative examples.

UNIT-4: Steam Turbines [12 hrs]

Classification, Single stage impulse turbine, condition for maximum blade efficiency, stage efficiency, Need and methods of compounding, Multi-stage impulse turbine, expression for maximum utilization factor, Reaction turbine – Parsons's turbine, condition for maximum utilization factor. Illustrative examples.

Text Books:

1. Kadambi and Manohar Prasad,**An Introduction to Energy Conversion, Volume III, Turbo machinery**, V New Age International Publishers, reprint 2008.
2. S. M. Yahya, **Turbines, Compressors & Fans**, Tata McGraw Hill Co. Ltd., 2nd edition, 2002.

Reference Books:

1. D. G. Shepherd**, Principals of Turbomachines**, The Macmillan Company (1964).
2. S. L. Dixon, **Fluid Mechanics & Thermodynamics of Turbomachines**, Elsevier (2005).
3. B.K.Venkanna **Turbomachine,** PHI, New Delhi 2009.
4. M. S. Govindgouda and A. M. Nagaraj **Text Book of Turbomachines**,, M. M. Publications, 4th Ed, 2008.
5. R.K.Rajput., **Thermal Engineering**, by Laxmi Publications

Soft Core -2

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
B18ME5031	**Power Plant Engineering**	SC	3	0	0	3	3
Prerequisites: Engineering Thermodynamics, Applied thermodynamics, Fluid Mechanics and Machinery		Internal Assessment: 40 Marks			Semester End Exam: 60 Marks		

Course Objectives:

1. To explore various methods of power generation using various resources.
2. To examine working principle and components used in power generation.
3. To describe the benefits and limitations of various types of power plants.
4. To describe parameters to be considered for starting the power plant.
5. To describe the limitations occurs for the power plants while producing the power.

Course Outcomes:

By the end of the course the students shall be able to:

1. Emphasize the working principle of the power plant.
2. Necessity the necessity of particular methods of power plant.
3. Judge the suitable power plant for suitable place.
4. Gain knowledge about cost analysis of power plant.

Course Content:

UNIT– 1 Steam Power Plant and Pulverized Fuel Furnaces [11 hrs]

Steam Power Plant: fuels used for steam generation, Equipment for burning coal in lump form, principle of stokers, Equipment for preparation and burning of pulverized coal, unit system and bin system.

Pulverized fuel furnaces: cyclone furnace, Natural, forced, induced and balanced draft.

Self-study: Coal & Ash Handling systems, different types of stokers

UNIT– 2 Steam Generators and Diesel Engine Power Plant [11 hrs]

Steam Generators And Cooling Towers: Super critical boilers, accessories for The Steam Generator such as super-heaters, de-super heater, Economizers, Air Pre-heaters, different types of cooling towers and ponds.

Diesel Engine Power Plant: Introduction, Layout of a diesel power plant, Method of starting diesel engines, Cooling and lubrication system for the diesel engine, Filters, oil heaters, Intake and exhaust system.

Self-study: Benson boiler, Volex boiler.

UNIT -3 Hydro-Electric Plants and Nuclear Power Plant [11 hrs]

Hydro-Electric Plants: Introduction, general layout, Storage and poundage, flow duration and mass curves, hydrographs, classification of hydro-electric plants, pumped storage plants, simple numerical.

Nuclear Power Plant: Principles of release of nuclear energy, Fusion and fission reactions. Elements of the Nuclear reactor- Moderator, control rod, fuel rods, coolants. Brief description of reactors - Pressurized water reactor (PWR), Sodium graphite reactor, Radiation hazards, Radio-active waste disposal.

*Self-study :*Survey of Hydel power station in India, Boiling water reactor (BWR)

UNIT–4 Choice of Site for Power Station and Economic Analysis of Power Plant [12 hrs]

Choice of Site for Power Station: load estimation, load duration curve, load factor, capacity factor, use factor, diversity factor, and demand factor, Effect of variable load on power plant, selection of the number and size of units.

Economic Analysis of Power Plant: Cost of energy production, selection of plant and generating equipment, performance and operating characteristics of power plants.

Self-study: Case study of any power plant**.**

Text Books:

1. P.K Nag, **Power Plant Engineering**, 3rd Ed. Tata McGraw Hill 2001.
2. Arora and Domkundwar, **Power Plant Engineering,** 8th edition Dhanpat Rai & Co.

Reference Books:

1. M M Ei Wakil, **Power Plant Technolgy** Tata McGraw Hill
2. Barrows, **Water Power Engg** Edition 3, TMH, New Delhi. 1998.
3. Stanier, **Plant Engg. Hand Book**, McGraw Hill. 1998.
4. Jagadish Lal, **Hydraulic Machines**, Metropollitan Co 1996.
5. R. K. Rajput, **Power Plant Engineering**, Laxmi publication, New Delhi.

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
B18ME5032	**Composite Materials**	SC	3	0	0	3	3
Prerequisites: MT ,MSM		Internal Assessment			Semester End Exam		
		40 Marks			60 Marks		

Course Objectives:

1. To classify the composite materials, highlight their applications in key areas
2. To provide a detailed understanding of metal matrix composites including types, application, fabrication and properties.
3. To provide thorough knowledge on ceramic matrix composites including, types, application, fabrication and properties
4. To provide a detailed understanding of polymer matrix composites including types, application, fabrication and properties.

Course Outcomes:

By the end of the course the student shall be able to

1. Classify the composites based on applications.
2. Describe the types and characteristics of Metal Matrix Composites
3. Describe the types and characteristics of Ceramic matrix composites.
4. Describe the types and characteristics of Polymer Matrix Composite.

Course Content:

UNIT–1 Composite Materials [11 hrs]

Definition, classification and characteristics of composite Materials – fibrous composites, laminated composites, particulate composites. Advantages, dis-advantages and Application of Composites in Automobile, Aircrafts. Missiles. Space hardware, Electrical and electronics, Marine, and sports equipment, future potential of composites.

UNIT–2 Ceramic Matrix Composites [11 hrs]

Metal Matrix Composites: Reinforcement materials, types, characteristics and selection base metals. Need for production MMC's and its properties.

Fabrication Process For MMC's: Powder metallurgy technique, liquid metallurgy technique and secondary processing, special fabrication techniques.

UNIT-3 Ceramic Matrix Composites [11 hrs]

Ceramic Matrix Composites: Reinforcement materials, types, characteristics and selection base materials. Need for production CMC's and its properties.

Fabrication Process For CMC's: hot pressing-reaction bonding process-infiltration technique, direct oxidation- interfaces.

UNIT–4 Polymer Matrix Composites [12 hrs]

Polymer Matrix Composites: Reinforcement materials, types, characteristics and selection base material, Need for production of PMC's and its properties.

Fabrication Process of PMC's: Handlay-up, spray technique, filament winding, Pultrusion, Resin Transfer Molding (RTM)-, bag molding, injection molding, Sandwich Mould Composites (SMC).

Text Books:

1. K. K. Chawla **Composite Science and Engineering**, Springer Verlag 1998.
2. Autar K. Kaw **Mechanics of composite materials**, CRC Press New York.

Reference Books:

1. P. K. Mallick, **Fiber Reinforced Composites**, Marcel Dekker,Inc
2. Robert M. Jones, **Mechanics of Composite Materials,** McGraw Hill Kogakusha Ltd.1998
3. Meing Schwaitz," **Composite Materials Hand Book**, McGraw Hill book company.1984
4. Ronald F. Gibron. **Principles of Composite Material Mechanics**, McGraw Hill international, 1994.
5. Madhujit Mukhopadhyay, **Mechanics of Composite Materials and Structures,** Universities Press 2009.

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
B18ME5033	**Hydraulics and Pneumatics**	SC	3	0	0	3	3
Prerequisites: Fluid Mechanics		Internal Assessment			Semester End Exam		
		40 Marks			60 Marks		

Course Objectives:

1. To acquire the knowledge of hydraulic and pneumatic systems.
2. Analyze the energy transfer in hydraulic actuators and motors and solve the Problems.
3. To impart the knowledge on controlling components of hydraulics and pneumatics systems.
4. Analyze the hydraulic and pneumatic circuits and interpret their applications.

Course Outcomes:

By the end of the course Student shell be able to

1. Identify and select the hydraulic and pneumatic systems based on requirement.
2. Explain the controlling components of hydraulic and pneumatic systems.
3. Compile the design of hydraulic and pneumatic circuit systems and analyze them.
4. Exposure to do the project.

Course Content:

UNIT -1 Introduction to Fluid Power [11 hrs]

Fluid Power System: Advantages of fluid power, Application of fluid power system. Basics of Hydraulics-Applications of Pascal's Law, Structure of Hydraulic System- Numerical on Pascal's law.

Hydraulic Pumps: Pumping theory – Gear pump, Vane Pump, Piston pump, construction and working of pumps – pump performance-Factors for selection of pumps–Numerical on hydraulic pumps.

UNIT -2 Hydraulic Actuators and Control Valves [11 hrs]

Hydraulic Motors and Control Valves: Gear motor, Vane motor, Piston motor, construction and working of motors– motor performance- Control Valves-DCV: check valve,3/2, 4/3, 5/2 PRV: Pressure reducing valve, FCV: needle valve. Fluid power symbols, Numerical on hydraulic motors.

Fluid Power Actuators: Linear hydraulic actuators – Types of hydraulic cylinders – Single acting, Double acting, Special types of cylinders, Loading Mechanism, Cylinder Mounting- Cylinder load, speed and power, Simple problems.

UNIT -3 Hydraulic Circuits and Maintenance [11 hrs]

Hydraulic Circuits: Single acting, Double acting, Regenerative, Double pump, Sequencing, Cylinder locking, Synchronizing, pump unloading circuit, counter balance circuit, Meter-in, Meter-out, Accumulators and Accumulator using circuits.

Maintenance of hydraulic Systems: Hydraulic oils – Desirable properties, Sealing Devices, Reservoirs System, Filters and strainers, Problem caused by Gases in Hydraulic Fluids, Wear of moving parts to solid particle contamination, Temperature control, Trouble shooting.

UNIT -4 Pneumatic and Servo Systems [12 hrs]

Pneumatic Systems and Components: Pneumatic Components: Properties of air – Compressors – Filter, Regulator, and Lubricator Unit – Air control valves, Quick exhaust valves, and pneumatic actuators.

Servo systems – Hydro Mechanical servo systems, Electro hydraulic servo systems and proportional valves. Fluidics – Introduction to fluidic devices, simple circuits, Introduction to Electro Hydraulic Pneumatic logic circuits.

Text Books:

1. Anthony Esposito, **Fluid Power with Applications**, Pearson Education 2000.
2. Majumdar S.R., **Oil Hydraulics**, Tata McGraw-Hill, New Delhi 2009.

References Books:

1. Majumdar S.R., **Pneumatic systems – Principles and Maintenance**, Tata McGraw Hill, New Delhi 2005.
2. Anthony Lal, **Oil hydraulics in the service of industry**, Allied publishers, 1982.

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
B18ME5034	**Production Management**	SC	3	0	0	3	3
Prerequisites: Nil		Internal Assessment			Semester End Exam		
		40 Marks			60 Marks		

Course Objectives:

1. To acquire the knowledge of production planning process and its functions
2. To study the fundamentals of Inventory management
3. To provide knowledge about MRP and ERP systems
4. To introduce the concepts of purchasing and supply chain management

Course Outcomes:

By the end of the course the student shall be able to:

1. Apply different types of tools and techniques for better production process.
2. Estimate forecast using different forecasting techniques
3. Determine optimal ordering quantity net requirements of dependent demand items
4. Define routing and dispatching procedure and evaluate vendors

Course Content:

UNIT-01 Introduction to Process Planning, Control and Forecasting [11 hrs]

Definitions, Objectives of production Planning and Control, Functions of production planning and control, Elements of production control, Types of production, Organization of production planning and control.

Forecasting – Importance of forecasting, Types of forecasting, their uses , General principles of forecasting, Forecasting techniques– qualitative methods and quantitative methods- Time Series methods, Exponential smoothing, Regression methods (with numerical).

UNIT-02 Operations Decision, Aggregate Planning and Master Scheduling [11 hrs]

Introduction, Characteristics of decisions, framework for Decision Making, Decision methodology, Decision supports systems, Economic models with numerical**.**

Planning and Scheduling, Objectives of Aggregate Planning, Aggregate Planning Methods, Master Scheduling Objectives, Master Scheduling Methods. (with numerical)

UNIT-03 Inventory Management, MRP and ERP: [11 hrs]

Definition and Need, Components Inventory, inventory control. Functions of inventories, relevant inventory costs – ABC analysis – VED analysis – EOQ model – Inventory control systems – P–Systems and Q-Systems. (with numerical)

Introduction to MRP & ERP, JIT inventory, and Japanese concepts. System Parameters, MRP Logic, System refinements, Capacity Management, CRP activities. Concept of continuous improvement of process. (with numerical)

UNIT-04 Routing – Dispatching and Supply Chain Management [12 hrs]

Definition, Routing & Dispatching procedure, Route sheets, Bill of material, Factors affecting routing procedure.

Introduction to supply chain management- Approaches to purchase and supply chain management, make or buy decision, e-Procurement, Vender development, rating, and certification.

Text Books:

1. Samuel Eilon, **"Elements of Production Planning and Control",** 1st Edition, Universal Publishing Corp., 1999.

Reference Books:

1. P Rama Murthy, **"Production and Operations Management**", 1st Edition, New Age, 2002.
2. Baffa & Rakesh Sarin, **"Modern Production / Operations Management**", 8th Edition, John Wiley & Sons, 2002.
3. S.N. Chary, **"Operations Management**", 1st Edition, TMH, 1996.
4. Joseph Monks, "**Operations Management Theory and Problems**", 3rd Edition, McGraw-Hills,1987.

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
B18ME5035	**Database Management System**	SC	2	0	1	3	4
Prerequisites: Nil		Internal Assessment			Semester End Exam		
		40 Marks			60 Marks		

Course Objectives:

1. To introduce the concepts of database and database design.
2. To make students to understand Oracle and Oracle tables.
3. To make the students to work with Table, Functions and Grouping.
4. To develop database programming skills in SQL.

Course Outcomes:

By the end of the course student shall be able to

1. Describe concepts involved in database design
2. Demonstrate the importance of Oracle and its table.
3. Describe the working with table, functions and grouping
4. Apply database concepts and relational models for building database applications to develop database programming skills in SQL.

Course Content:

UNIT -01 Database Concepts and Database Design [11 hrs]

Database Concepts: A Relational approach: Database – Relationships – DBMS – Relational Data Model – Integrity Rules – Theoretical Relational Languages.

Database Design: Data Modeling and Normalization: Data Modeling – Dependency – Database Design – Normal forms – Dependency Diagrams – De normalization – Examples of Normalization.

UNIT-02 Oracle9i and Oracle Tables [11 hrs]

Oracle9i : Overview: Personal Databases – Client/Server Databases – Oracle9i an introduction – SQL *Plus Environment –SQL –Logging into SQL *Plus - SQL *Plus Commands – Errors & Help – Alternate Text Editors - SQL *Plus Worksheet - SQL *Plus.

Oracle Tables: DDL: Naming Rules and conventions – Data Types –Constraints – Creating Oracle Table – Displaying Table Information –Altering an Existing Table – Dropping, Renaming, Truncating Table – Table Types – Spooling – Error codes.

UNIT-03 Working with Table, Functions and Grouping [11 hrs]

Working with Table: Data Management and Retrieval: DML –adding a new Row/Record – Customized Prompts – Updating and Deleting an Existing Rows/Records – retrieving Data from Table – Arithmetic Operations – restricting Data with WHERE clause – Sorting – Revisiting Substitution Variables – DEFINE command – CASE structure. Functions and Grouping: Built - in functions – Grouping Data. Multiple Tables: Join – Set operations.

UNIT-04 PL/SQL and Control Structures and Embedded SQL [12 hrs]

PL/SQL: A Programming Language: History – Fundamentals – Block Structure – Comments – Data

Types – Other Data Types – Declaration – Assignment operation – Bind variables – Substitution Variables – Printing – Arithmetic Operators.

Control Structures and Embedded SQL : Control Structures – Nested Blocks – SQ L in PL/SQL – Data Manipulation – Transaction Control statements.

Text Books:

1. Nilesh Shah, **Database Systems Using Oracle** 2nd edition, PHI.

Reference Books:

1. Arun Majumdar & Pritimoy Bhattacharya, **Database Management Systems** 2007, TMH.
2. Gerald V. Post, **Database Management Systems** 3rd edition, TMH.

Soft Core-3

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
B18ME5041	**Renewable Energy Resources**	SC	3	0	0	3	3
Prerequisites: Concept on Energy resources		Internal Assessment			Semester End Exam		
		40 Marks			60 Marks		

Course Objectives:

1. Present an overview of global energy sources.
2. Introduce various renewable energy sources and types of power plants.
3. Present the harnessing techniques of renewable energy sources.
4. Present the applications and problems encountered in harnessing renewable energy sources.
5. Present the production and storage techniques of future (hydrogen) energy source.

Course Outcomes:

By the end of the course the student shall be able to

1. Describe the fundamentals and main characteristics of renewable energy sources and their differences compared to fossil fuels.
2. Describe the fundamentals and harnessing techniques of biomass energy sources.
3. Explain the methods of solar energy measurements and its applications.
4. Describe the main components of renewable energy conversion systems and technological basis for harnessing sources.

Course Content:

UNIT -1: Energy Sources and Future Energy [11 hrs]

Energy Sources: Introduction, India's production & reserves of commercial and renewable energy sources, need for non-conventional energy resources, advantages and limitations of conventional and non-conventional energy resources.

Future Energy: Introduction to hydrogen energy, source of hydrogen energy,methods of hydrogen production, hydrogen storage and transportation, safe burning of hydrogen, advantages, limitations & applications of hydrogen energy.

Self-Study-Future applications of Hydrogen Energy.

UNIT -2: Energy from Biomass [11 hrs]

Biomass Energy Sources: Introduction, energy farming-Energy plantation, origin of biomass-Photosynthesis process, Energy through fermentation - ethanol production from sugarcane and starch.

Bio-methanization: Anaerobic digestion, Basic principles, factors affecting biogas yield, biogas digester-floating gas holder and fixed dome type with working principle and diagram, calculation for siz**ing** biogas plant.

Self-Study: A case study on different uses of organic matter.

UNIT -3: Solar Energy and Applications [11 hrs]

Solar Energy: Solar radiation ,solar constants, availability, measurement and estimation, Solar radiation geometry, Flux on a plane surface, latitude, declination angle, surface azimuth angle, hour angle, zenith angle, solar altitude angle expression for the angle between the incident beam and the normal to a plane surface (No derivation) local apparent time, day length, simple numerical.

Applications: solar collectors -liquid flat plate collectors and air heaters-working principle with diagram, Thermal storage , Sensible and latent heat storage, and Solar distillation- PV cell- solar furnace.Self-Study: Solar Pond , solar greenhouse, Solar Application in space.

UNIT -4: Renewable Energy Conversion Systems [12 hrs]

Ocean Thermal Energy Conversion System: Rankine cycle -working principle with diagram, problems encountered in OTEC, advantages and limitations of OTEC systems.

Tidal Power: Principle of formation of tides, single and double basin system of harnessing tidal power(working principle with diagram), advantages and limitations of tidal power plants.

Wind Power: Harnessing wind power -HAWT& VAWT, working principle with diagram, advantages and limitations of wind power, simple numerical.

Geothermal Energy Conversion Systems: Harnessing geothermal energy -working principle with diagram, advantages, limitations and problems associated with geothermal energy conversion systems, scope of geothermal energy.Self-Study: Power from wind

Text Books:

1. *G.D Rai K, .* **Non-Conventional Energy Sources** Khanna Publishers, 2003.
2 *Subhas P Sukhatme* **Solar energy,** Tata McGraw Hill, 2nd Edition, 1996

Reference Books:

1. N.K.Bansal, Manfred Kleeman & Mechael Meliss, **Renewable Energy Sources**
2. **and Conversion Technology** Tata McGraw Hill, 2001.
3. B H Khan **Non-conventional Resources**, TMH – 2007
4. David Merick, Richard Marshall, (2001), **Energy, Present and Future Options, Vol. I and II**, John Wiley and sons
5. Domakundawar, **Power Plant Engineering**, Dhanpath Rai sons. 2003

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
B18ME5042	**Theory of Elasticity**	SC	3	0	0	3	3
Prerequisites: SOM		Internal Assessment			Semester End Exam		
		40 Marks			60 Marks		

Course Objectives:

1. To enable the students to understand equilibrium equation for elastic body and to obtain stress-strain components for the elastic component.
2. Provide systematic basic knowledge for two dimensional problems in Cartesian Co-ordinates and Polar Co-Ordinates
3. To enable the students to understand axis symmetric problems and to formulate the torsional equation for different members
4. Formulate the thermo-elastic stress-strain relation for different members and to understand the basic principles of the theorem.

Course Outcomes:

By the end of the course the student shall be able to

1. Demonstrate the fundamentals of equilibrium equation and analyze the Stress and Strain.
2. Formulate two dimensional problems of cylindrical bodies in Cartesian Co-ordinates and Polar Co-Ordinates.
3. Determine the Stresses in Rotating Discs, Cylinders and Torsional Prismatic Bars.
4. Derive the thermal equilibrium equations and Thermal stresses in thin circular discs, long circular cylinder and sphere.

Course Content:

UNIT – 1 Analysis of Stress-Strain Relation [11 hrs]

Analysis of Stress: Definition and notation of Stress, Stress at a Point, Equilibrium Equations, Principal Stresses, Mohr's Diagram, Maximum Shear Stress.

Analysis of Strain: Strain Components, Compatibility Equations, Principal Strains, Generalized Hooke's law, Plane Stress- Plane Strain Problems.

UNIT– 2 Two Dimensional Problems in Cartesian Co-ordinates [11 hrs]

Two Dimensional Problems in Cartesian Co-ordinates: Airy's stress functions, Bi-harmonic Equation – Investigation of Airy's Stress function for simple beam problems – Bending of a narrow cantilever beam of rectangular cross section under edge load

General Equations In Polar Co-Ordinates: Equilibrium Equations, Thick cylinder under uniform internal and / or external pressure, shrink and force fit.

UNIT– 3 Rotating Disc, Cylinder and Torsion Bar [11hrs]

Stresses in Rotating Disc and Cylinder: Stresses in rotating discs and cylinders, stresses in an infinite plate(with a circular hole) subjected to uniaxial and biaxial loads, stress concentration.

Torsion of Prismatic Bars: Torsion of Circular, Elliptical and Triangular Bars, Membrane Analogy.

UNIT– 4 Thermal Stresses [12 hrs]

Thermo elastic stress strain relationship, Equations of equilibrium Thermal stresses in thin circular discs and in long circular cylinder, sphere.

Uniqueness Theorem, Principle of super position, Reciprocal theorem, Saint Venant's principle.

Text Books:

1. L. S. Srinath, **Advanced Mechanics of solids**, Tata Mc. Graw Hill,2003

2. S. P. Timoshenko and J. N Gordier, **Theory of Elasticity,** Mc.Graw Hill International, 3rd edition, 1972

Reference Books:

1. Dr. Sadhu Singh **Theory of Elasticity,** , Khanna Publications, 1988
2. Martin H Sadd,**Elasticity, Theory, Applications & Numericals,** Elsevier. 2005
3. Seetharamu & Govindaraju **Applied Elasticity,** , Interline Publishing
4. C.T. WANG Sc. D. **Applied Elasticity,** McGraw Hill Book Co.1953

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
B18ME5043	**Non Traditional Machining**	SC	3	0	0	3	3
Prerequisites: Manufacturing Process		Internal Assessment			Semester End Exam		
		40 Marks			60 Marks		

Course Objectives:

1. To describe the principles of material removal mechanism of advanced machining processes such as mechanical, electro-chemical and thermal.
2. To explore in-depth knowledge in selection of advanced machining process to fabricate intricate and complex shapes in difficult to machine material.
3. To develop awareness of advanced finishing processes to achieve submicron/nano surface finish.
4. To acquire the knowledge of the applications of Radiant energy processes in various fields.

Course Outcomes:

By the end of the course students shall be able to

1. Identify and suggest the suitable manufacturing process for advanced materials and critical finishing.
2. Customize the machining parameters for components used in aircraft applications
3. Apply the knowledge of various factors influencing the processes and their applications.
4. Examine the sophisticated and advanced equipment such as LBM, EBM,

Course Content:

UNIT– 1 Ultrasonic Machining [11 hrs]

Importance of NTM, History, Classification, Need and comparison between conventional and Non-conventional machining process.

Ultrasonic Machining: equipment, tool materials & tool size, abrasive slurry, Effect of process parameters: Effect of amplitude and frequency and vibration, Effect of abrasive grain diameter, effect of applied static load, effect of slurry, tool & work material. Applications, Advantages & Disadvantages of USM.

Water Jet Machining: Principal, Equipment, Operation, Application, Advantages and limitations of water Jet machinery

UNIT– 2 Abrasive Jet Machining and Electrochemical Machining Process [11 hrs]

Abrasive Jet Machining: Equipment, Variables in AJM: Carrier Gas, Type of abrasive, size of abrasive grain, velocity of the abrasive jet, mean number. abrasive particles per unit volume of the carrier gas, work

material, standoff distance (SOD), nozzle design, shape of cut. Applications, advantages & Disadvantages of AJM.

Electro Chemical Machining: study of ECM machine, elements of ECM process. Cathode tool, Anode work piece, source of DC power, Electrolyte, chemistry of the process, ECM Tooling, Electrolyte flow arrangement, Advantages and Limitations.

UNIT–3 Chemical Machining Process and Electric Discharge Machining [11 hrs]

Chemical Machining –Steps in CHM, process characteristics of CHM: material removal rate, accuracy, surface finish, Hydrogen embrittlement, advantages & application of CHM.

Electric Discharge Machining: Principle, Construction and Mechanism of metal removal, Electrode feed mechanism, Dielectric fluid, Tool materials in EDM, EDM process characteristics: metal removal rate, accuracy, surface finish, Applications, advantages & Disadvantages of EDM.

UNIT– 4 Plasma Arc Machining, LBM and EBM Processes [12 hrs]

Plasma Arc Machining: Introduction, equipment, non-thermal generation of plasma, selection of gas, Mechanism of metal removal, PAM parameters, process characteristics. Safety precautions, Applications, Advantages and limitations.

Laser Beam Machining: Introduction, equipment of LBM mechanism of metal removal, LBM parameters, Process characteristics, Applications, Advantages & limitations.

Electron Beam Machining: Principles, equipment, operations, applications, advantages and limitation of EBM

Text Books:

1. Pandey and Shan, **Modern Machining Process**, Tata McGraw Hill 2000
2. Bhattacharya **New Technology**, 2000

Reference Books:

1. 1 HMT **Production Technology**, Tata McGraw Hill. 2001
2. Aditya, **Modern Machining Process** 2002
3. P.K.Mishra, **Non-Conventional Machining**, The Institution of Engineers (India) Test book series, Narosa Publishing House –2005.

4.Joseph R. Davis (Editor), **Metals Handbook: Machining Volume 16**, American Society of Metals (ASM).

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
B18ME5044	**Materials Management**	SC	3	0	0	3	3
Prerequisites: None		Internal Assessment			Semester End Exam		
		40 Marks			60 Marks		

Course Objectives:

1. To provide knowledge about integrated materials management system
2. To Introduce the concepts of vendor development, legal aspects of purchasing
3. To impart knowledge of stores management, classification of inventory and different inventory systems
4. To acquire knowledge of MRP ERP and latest and modern concepts of Inventory.

Course Outcomes:

By the end of the course the students shall be able to:

1. Explain purchasing procedure and integrated materials management system
2. Evaluate vendors and analyze cost benefit
3. Classify inventory based on criticality and consumption value
4. Calculate EOQ and net requirements of dependent items.

Course Content:

UNIT– 1 Materials Management and Purchasing [11 hrs]

Importance of Materials Management: Definition and scope, organization for materials management, Integrated Materials Management, Micro and Macro factors in Materials Management and planning for materials.

Purchasing: Introduction, Functions, objectives and scope of purchasing. Organization for purchasing, procedures forms and records for purchasing, Methods of purchasing, Centralized and decentralized purchasing.

UNIT– 2 Purchasing Activities and its Control [11hrs]

Vendor development: Selection of sources of supply, supplier evaluation, Rating of vendors, Price-cost analysis. Legal aspects with reference to Indian context. Law of Agency, Import and export regulations, Negotiations, purchasing reports: Price, Administrative, Inventory and procurement performance.

UNIT–3 Stores Management [11 hrs]

Organization of stores location and layout, Functions of storekeeping, Receipt, Inspection, storage and issue of materials. LIFO, FIFO, Average cost and other methods of accounting. Two bin systems of inventory control, control of damage, pilferage and obsolescence of goods. Classification and coding of materials, ABC and VED analysis, Lead time control and evaluation.

UNIT–4 Inventory Control and Models [12 hrs]

Need, scope and importance of inventory, impact on profitability, modern concepts of inventory, JIT, MRP and other relevant techniques. Lead time analysis and safety stock planning with respect to procurement policy. Inventory costs: ordering costs, shortage costs, Inventory carrying costs, work in process. EOQ Models with numerical.

Text Books:

1. Gopal krishnan and Sunderesan , **Materials Management** , PHI
2. Arnold.J , Chapman S ad Ramakrishnan.R, **Introduction to Materials Management**, Pearson.
3. Gopal Krishnan.P , **Purchasing and Materials Management**, TMH Publisher.

Reference Books:

1. Gopal Krishnan.P , **Hand book of Materials Management ,** PHI
2. A.K.Datta , **Materials Management: Procedures, Text and cases**, PHI
3. Starr and Miller, **Inventory Control**, PHI.

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
B18ME5045	**Java Programming**	SC	2	0	1	3	4
Prerequisites: None		Internal Assessment			Semester End Exam		
		40 Marks			60 Marks		

Course Objectives:

1. To understand fundamentals of programming such as variables, conditional and iterative execution, methods, etc.
2. To understand fundamentals of object-oriented programming in Java, including defining classes, invoking methods, using class libraries, etc.
3. To be able to use the Java SDK environment to create, debug and run simple Java programs.

Course Outcomes:

By the end of the course student shall be able to

1. Describe the structure and model of the Java programming language
2. Differentiate between different types of decision making statements.
3. Create basic application using the Java programming language.
4. Describe Packages and Managing Exceptions.

Course Content:

UNIT–1 Introduction to JAVA [11 hrs]

JAVA Evolution: Java History, Java Features, Overview of JAVA Language: Introduction, Java Program structure, Java Tokens, Java Statements, , Java Virtual Machine, Command Line Arguments,. Constants, Variables, and Data Types Scope of variables, Symbolic Constants, Type Casting, Operators and Expressions; Arithmetic Expressions, Evaluation of Expressions, Precedence of Arithmetic Operators, Type conversion and Associativity, Mathematical Functions.

UNIT–2 Control Structures and Classes [11 hrs]

Decision Making and Branching: Introduction, Decision Making Statements, Looping: while, do, for Statement, jumps in loops, labeled loops, Classes, Objects and Methods: Introduction, Defining a Class, Adding Variables, Adding Methods, Creating Objects, Accessing Class Members, Constructors, Methods Overloading, Static Members, Nesting of Methods.

UNIT–3 Inheritance, Arrays, Strings, Vectors and Interfaces [11 hrs]

Inheritance: Extending a Class Overriding Methods, Final Variables and Methods, Finalizer methods, Abstract Methods and Classes, Visibility Control. Arrays, Strings and Vectors: Arrays, One dimensional Arrays, Creating an Array, Two– dimensional Arrays, Strings, Vectors, Wrapper Classes, enumerated types, Interfaces: Multiple Inheritance: Introduction, Defining Interfaces, Extending Interfaces, Implementing Interfaces, Accessing Interface Variables.

UNIT–4 Packages and Managing Exceptions [12hrs]

Packages: Putting Classes together: Introduction, Java API Packages, Using System Packages, Naming Conventions, Creating Packages, Accessing a Package, Using a Package, Adding a Class to a Package, Hiding Classes., Java Collections, Managing Errors and Exception: Introduction, Types of Errors, Exceptions, Syntax of Exception Handling Code, Multiple Catch Statements, Using Finally Statement, Throwing Our Own Exceptions.

Text Books:

1. A.Balaguruswamy, "**Programming with JAVA**", A Primer, TMH, 1999.

Reference Books:

1. Thomas Boutel, "**CGI programming in C and Perl**",Addison – Wesley, 1996.
2. Jefry Dwight et al, **Using CGI**, Second Edition, Prentice Hall, India, 1997
3. Patrick Naughton & Herbert Schildt, **JAVA 2: The Complete Reference**, THM, 1999.
4. Schildt, "**JAVA The Complete Reference**", 7th Edition.

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
B18ME5150	**Dynamics of Machines**	HC	3	1	0	4	5
Prerequisites: KOM, MOM		Internal Assessment			Semester End Exam		
		40 Marks			60 Marks		

Course Objectives:

1. To explain the equilibrium conditions, static and dynamic force analysis for different mechanisms and to draw the turning moment diagram of flywheel
2. To explain the analytical approach and graphical methods (force and couple polygon) in balancing the unbalanced rotating and reciprocating engines.
3. To explain the application of governors in controlling the mean speed of an engine and belt drives
4. To introduce the concept of gyroscopic effect in analyzing the stability of disc, two wheeler, four wheeler, ships and aero planes.

Course Outcomes:

By the end of the course student shall be able to

1. Describe the condition for equilibrium of member under the action of forces, draw the free body diagram & analyze the static forces on slider crank mechanism, four bar mechanism and determination of size of flywheels.
2. Apply the analytical approach and graphical methods (force and couple polygon) in balancing the unbalanced rotating and reciprocating engines.
3. Determine the mean speed and performance parameters of governors and compute the ratio, centrifugal tension and power of belt drives.
4. Analyze the gyroscopic effect on aero plane, naval ships and in automobiles.
5.

Course Content:

UNIT-1 Static, Dynamic Force Analysis and Flywheel [11hrs]

Static & Dynamic Force Analysis: Introduction, Static equilibrium. Equilibrium of two and three force members. Members with two forces and torque. Free body diagrams. Static force analysis of four bar

mechanism and slider-crank mechanism with and without friction. Principle of virtual work. D'Alembert's principle and its application.

Flywheel: Turning moment diagrams and flywheels. Fluctuation of Energy. Determination of size of flywheels.

UNIT-2: Balancing of Rotating Masses and Reciprocating Masses [11hrs]

Balancing of Rotating Masses: Static and dynamic balancing. Balancing of several rotating masses by balancing masses in same plane and in different planes.

Balancing of Reciprocating Masses: Balancing of primary force in reciprocating engine, partial balancing of multi cylinder locomotives inline engine and V- engine. Numerical.

UNIT-3: Governors and Belt Drives [13hrs]

Governors: Introduction, principles, Types of governors, Terminology, force analysis of Porter and Hartnell governors, sensitivity, stability, Hunting, Isochronism, effort and power of governor, controlling force diagram. Numerical.

Belt drives: Flat belt drives, ratio of belt tension, centrifugal tension, power transmission.

UNIT-4: Gyroscopic Motion [10 hrs]

Principles, Gyroscopic Torque, effect of gyroscopic couple on the stability of disc, aero plane, ship, Two wheeler and four wheeler.

Text Books:

1. S.S. Rattan, **Theory of Machines**, Tata McGraw Hill Publishing Company Ltd., New Delhi, 3rd edition, 2013.
2. R K Bansal, **Theory of Machines**- 6th edition, Laxmi Publications.
3. R S Khurmi & J K Gupta, **Theory of Machines**, 5th edition, S. Chand Publications.

Reference Books:

1. Dr. Sadhu singh, **Kinematics of Machines**-2nd edition, Pearson publication.
2. Thomas Bevan, **Theory of Machines**- 3rd edition, CBS Publication.
3. Shigley, **Theory of Machines**- 3rd edition McGraw hill Book Company.

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
B18ME5160	**Metal Forming Process**	HC	3	0	0	3	3
Prerequisites: Manufacturing Technology		Internal Assessment			Semester End Exam		
		40 Marks			60 Marks		

Course Objectives:

1. The course will enable the students to acquire a fundamental knowledge on metal forming technology which is necessary for an understanding of industrial processes.
2. To introduce students to the wide range of materials and processes, which are currently used in manufacturing industry?
3. The course will also provide methods of analysis allowing a mathematical/physical description of forming processes.

4. The course will enable the students to identify the processes characteristics, select the main operator parameters, the tool geometry and materials, and determine forces and power required to select the main and auxiliary equipment.

Course Outcomes:

By the end of the course students shall be able to

1. The students should learn and understand necessity of forming process compared with other manufacturing techniques
2. The learning of various methods of forming gives an idea for the selection of a process for different materials
3. The students should know the parameters effect on the processing of the wrought products.
4. Students should be able to select the process, load required and possible reasons for the formation defects of the forged components
5. The students should have the knowledge to identify and analyze production of wire, rod , tubes using different processes and problems occurred in the process

Course Content:

UNIT-1: Introduction [11 hrs]

Classification of metal forming processes, Hot working and cold working , advantages and limitations of metal working processes. Concepts of true stress and true strain, Relationship between conventional and true strain. Variables in Metal forming**:** Temperature in metal forming, strain rate or Deformation velocity, Grain size and microstructure, Friction in metal forming, Lubrication in metal forming, Formability of materials, Deformation zone geometry, hydrostatic pressure, Residual stresses in metal working.

UNIT- 2: Forging and Rolling [11 hrs]

Classification of Metal Forming Processes, Hot working and cold working of metals

Forging: classification of forging processes – Open, impression and closed die forging, Typical forging operations, forging defects, advantages and disadvantages of forging, Simple problems on forging load calculations.

Rolling: classification of rolling process, rolling mills, rolling variable and defects in rolled parts, Simple problems on rolling load.

UNIT -3: Drawing and Extrusion [11 hrs]

Drawing: Principle of rod and wire drawing, Tube drawing and its classification, Simple problems.

Extrusion: Types of extrusion processes, Extrusion of seamless tubes and defects in extrusion, Simple problems on extrusion.

UNIT -4: Sheet Metal and High Energy Rate Forming [12 hrs]

Sheet metal forming methods, Dies and punches, Rubber forming. Stretch forming, LDR in drawing, defects in deep drawn products, piercing, blanking, bending, deep drawing, stretch forming, simple problems.

High Energy Rate Forming Methods and Powder Metallurgy: Introduction , Principles, advantages and applications, explosive forming, electro hydraulic forming, Electromagnetic

forming. Basic steps in Powder metallurgy , application of powder metallurgy components, advantages and limitations.

Text Books:

1. G.E. Dieter, **Mechanical Metallurgy** (SI units), Mc Graw Hill pub.2001

2. Dr. K.Radhakrishna, **Manufacturing Process – III**, Sapna Book House, 2009.

Reference Books:

1. E.paul, Degramo, J.T. Black, Ronald, A.K. **Materials and Processes in Manufacturing**, Prentice -hall of India 2002
2. G.W. Rowe, **Principles of Industrial metal working process**, CB Spub. 2002
3. Amitabha Ghosh & A.K. Malik - **Manufacturing Science,** East – West press 2001
4. Surendrakumar, **Technology of Metal Forming Process**, PHI –2008.

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
B18ME5170	**Internal Combustion Engines Lab**	HC	0	0	2	2	3
Prerequisites: Applied Thermodynamics		Internal Assessment			Semester End Exam		
		20 Marks			30 Marks		

Course Objectives:

1. To learn the various methods used for testing of IC engines..
2. To know performance of the engines and different loads.
3. To know the various heat losses by drawing heat balance sheet.
4. To learn the performance of the compressor and blower
5. To study the performance of the refrigerator and air-conditioner.

Course Out comes:

By the end of the course the student shall be able to

1. Define IC terminology like IP, BP, SFC, BSFC, ISFC.
2. Determine the BP, IP, efficiency of the engines under various loads.
3. Find out the COP of the refrigeration and air conditioning test rig.
4. Prepare the document of the experimental work.

List of Experiments:

1. Determination of area of regular and irregular surface Using Planimeter.
2. Draw the Valve timing diagram of four stroke diesel engine.
3. Conduct performance test on single cylinder two stroke petrol engine.
4. Conduct performance test on single cylinder four stroke petrol engine.
5. Conduct performance test on single cylinder four stroke diesel engine.
6. Determination of frictional power of multi cylinder petrol engine using Morse test.
7. Determination the effect of variable compression ratio on four stoke single cylinder VCR petrol engine
8. Determination of volumetric efficiency and overall efficiency of two stage air compressor
9. Conduct performance to determine the overall efficiency of air Blower
10. Determination of relative COP of Vapour Compression Refrigeration system
11. Conduct the performance test on Vapour compression air condition system

Demo Experiments

1. Preparation of Biodiesel from vegetable oil (edible and non edible) and animal fat by transesterification process.
2. Measurement of emissions such as HC,CO,CO_2,$O_2$and NOx from the exhaust of diesel engine with the help of five gas exhaust gas analyser (AVL 440)
3. Measurement of smoke from the exhaust of diesel engine by AVL smoke meter.

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
B18ME5180	**Design and Dynamics Lab**	HC	0	0	2	2	3
Prerequisites: DOM and ESA		Internal Assessment			Semester End Exam		
		20 Marks			30 Marks		

Course Objectives:

1. To learn the testing procedure in design field.
2. To know the frequency of the rotating objects
3. To know the stress and strain in the component when it undergoes various types of loads.
4. To understand the stress concentration in the elements.
5. To learn the use of strain gages and its working principle

Course Outcomes:

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

1. Define frequency, critical speed and terminologies used in the dynamics of machines.
2. Determine the stresses and strains in the components.
3. Analyze the equilibrium speed, sensitiveness, power and effort of governors.
4. Define stress concentration and its importance and determine the stress concentration factor.

List of Experiments:

PART – A

1. Determination of natural frequency, logarithmic decrement, damping ratio and damping coefficient in a single degree of freedom vibrating systems (longitudinal and torsional)
2. Determination of critical speed of a rotating shaft.
3. Determination of Fringe constant of Photo elastic material using.
    a) Circular disc subjected to diametrical compression.
    b) Pure bending specimen (four point bending)
4. Balancing of rotating masses.
5. Determination of Principal Stresses and strains in a member subjected to combined Loading using Strain rosettes.
6. Determination of pressure distribution in journal bearings
7. Determination of equilibrium speed, sensitiveness , power and effort of porter governor
8. Experiment on Gyroscope (demonstration only)

PART – B

1. Introduction to MATLAB- Capabilities, Commands and creating m-files.

2. Variations of the natural frequency and the time period with static deflection of an undamped system.
3. Free-Vibration Response of a Spring-Mass System.
4. Unforced Response Spring Mass Damper System.
5. Simulation of Simple Pendulum.
6. Simulation of Three Bar Linkage Mechanism.

Details of the Exercises:

A. Plot the variations of the natural frequency and the time period with static deflection of an undamped system using MATLAB for deflection range of 0 to 0.5 cm

1) A spring-mass system of 20 kg with a mass of and stiffness 500 N/m is subject to an initial displacement of x_0 = 30 mm and an initial velocity of 40 mm/sec Plot the time variations of the mass s displacement, velocity, and acceleration using MATLAB.
2) Solve for five cycles, the response of an unforced system given by the equation

$$m\ddot{x}+c\dot{x}+kx=0$$

For ξ= 0.1; m = 1 kg; k = 100 N/m; x (0) = 0.02 m;.$\dot{x}(0)$ = 0;

3) Compute and plot the linear response of a simple pendulum having a mass of 10 grams and a length of 5 cms. The initial conditions are $\theta(0) = 90^0$ and $(\theta)^{\cdot} 0 = 0$. Also compare the generated plot with the nonlinear plot.
4) For the three-bar-linkage mechanism ,for a constant rotation rate ω of link L1, determine and plot the angular displacements of links L2 and L3 for one cycle of rotation of L1. Choose L1, L2 and L3 as 0.35m, 1m and 1m respectively Also choose 'a' and 'b' as 0.6m and 0.4m respectively. The angular velocity, ω of linkL1 is chosen to be 3 rad/sec

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
B18ME5250	**Heat Transfer**	HC	3	1	0	4	5
Prerequisites: Engineering Thermodynamics, Fluid Mechanics and Machinery		Internal Assessment			Semester End Exam		
		40 Marks			60 Marks		

Course Objectives:

1. Introduce the basic principles and laws governing the heat transfer.
2. Identify and compare the various modes of heat transfer, combined heat transfer processes and special heat transfer processes.
3. Provide a strong foundation for analysis of complex heat transfer problems and special heat transfer process using heat transfer data hand book.
4. Present a strong foundation to design heat exchangers, analyze boiling and condensation process using heat transfer data hand book.
5. Introduce various terms, laws of radiation heat transfer and to compute radiation exchange.

Course Outcomes:

By the end of the course student shall be able to

1. Define heat transfer and compare the three modes of heat transfer.
2. Identify different thermal processes, and derive the basic expressions for heat conduction, convection and radiation based on the First Law of Thermodynamics.
3. Analyze heat transfer problems using electrical resistance network analogy.

4. Discuss and analyze the applications of heat transfer problems using fins and critical thickness of insulation.
5. Analyze transient conduction problems using LSA and charts.
6. Define laws of radiation heat transfer; evaluate the radiation exchange between two finite and infinite surfaces.

Course Content:

UNIT -1: Introduction and Conductive Heat Transfer I [11 hrs]

Introduction to Heat transfer: Modes of heat transfer, basic laws of heat transfer, Initial conditions and boundary conditions, Thermal contact resistance, Overall heat transfer coefficient, 3-D heat conduction equation in Cartesian co-ordinates, Discussion on 3-D conduction equation in Cylindrical & Spherical coordinates, Discussion on 1-D steady state heat conduction without heat generation (plane wall, cylinders & spheres), Heat transfer through composite wall and numerical.

Conductive Heat transfer I: Critical thickness of insulation on spheres and cylinders, Fins-types of fins, Discussion on governing equations for different conditions of fins, effectiveness & efficiency of fin, Numerical.

UNIT -2: Conductive Heat Transfer II and Convective Heat Transfer I [11 hrs]

Conductive Heat transfer II (1-D Transient Conduction): Lumped system Analysis, Use of Heisler's charts for transient conduction in plane slab, long cylinder and sphere. Numerical examples.

Convective Heat transfer I: Concepts and basic relations in boundary layers: Hydrodynamic and thermal boundary layer over a flat plate, critical Reynolds number, Local heat transfer coefficient, average heat transfer coefficient, internal flow through duct, Numerical. .

Free or Natural Convection: Applications of dimensional analysis for free convection, physical significance of Grashoff number, Use of correlations for free convection of plates, cylinders, spheres, Numerical.

UNIT -3: Convective Heat Transfer II and Radiation Heat Transfer [11 hrs]

Convective Heat transfer II: Forced Convection- Applications of dimensional analysis for forced convection, physical significance of Reynolds, Prandtl, Stanton, Nusselt numbers, Use of correlations for hydro dynamically and thermally developed flows in case of internal and external flows ,laminar and turbulent flow solutions .

Radiation Heat transfer: Thermal radiation, definitions of various terms, Laws of black body radiation- Stefan Boltzmann , Weins displacement law, Kirchoff's law, Planck's law, Black body concept, Discussion on radiation shape factor, Discussion on heat exchange between two gray bodies(Infinite parallel planes),Discussion on effect of radiation shields, Numerical.

UNIT -4: Heat Exchangers and Phase Change Convective Process [12 hrs]

Heat Exchangers: Classification, Overall heat transfer coefficient, fouling and fouling factors, LMTD, Discussion on effectiveness-NTU methods of analysis of heat exchangers, Numerical.

Phase Change Convective Process: Condensation, Use of condensation correlations for flat vertical plate, horizontal tube and tube banks, Reynolds number for condensate flow.

Boiling-types of boiling, Regimes of pool boiling, Pool boiling correlations, Numerical.

Text books:

1. Tirumaleshwar, **Heat & Mass transfer**, Pearson education 2006
2. Ozisik, **Heat transfer-A basic approach**, Tata McGraw Hill 2002.

Reference books:

1. Yunus A-Cengel, **Heat transfer-A practical approach,** Tata McGraw hill.
2. Mahesh M Rathore, **Heat and mass transfer,** Laxmi publications.
3. Kreith **Principles of Heat transfer,** Thomas Learning 2001
4. Frenk P.Incropera and DavidP.Dewitt, **Fundamentals of heat and mass transfer**,John Wiley and son's.
5. R K Rajput , **Heat and Mass transfer,** S Chand Publications**.**

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
B18ME5260	**CAD/CAM/CIM**	HC	3	0	0	3	3
Prerequisites: Theory of metal cutting & machine tool		Internal Assessment			Semester End Exam		
		40 Marks			60 Marks		

Course Objectives:

1. To obtain the fundamentals of CAD/ CAM / CIM and related concepts to understand the various modeling features and its manufacturing.
2. Interpret various concepts of CAD /CAM /CIM, the product development cycle can be reduced in the design stages and also reduction of Manufacturing Lead time.
3. Developing the NC programming and its importance in practical applications by using coding system.
4. To have a hands on experience on various tools used for modeling and manufacturing aspects.
5. To study about the line balancing in automated flow lines.

Course Outcomes:

By the end of the course student shall be able to

1. Analyze the basic principles of CAD & CAM in engineering applications.
2. Create geometric models of components by using software and generation of part programming by using machine language codes.
3. Reduction of Manufacturing Lead time and Product development time.
4. Evaluate the performance of automated flow lines.

Course Content:

UNIT - 1 Fundamentals of CAD [11 hrs]

Fundamentals of CAD: Definition of CAD/CAM, Product cycle and its cad / cam over laid, Design process & application of computers for design, creating the manufacturing database, Benefits and achievement of CAD.

Computer Graphics: Raster Scan Graphics, Coordinate Systems, Database Structure for Graphic Modeling, functions of graphics package, Transformation of geometry, 2D transformations – Simple problems. Geometric Modeling: Curve Representation, Surface Representation methods.

UNIT -2 Introduction to NC Technology [11 hrs]

NC Technology: Basic components of NC system, NC Coordinate system, types of NC motion control systems, advantages and applications of NC. CNC & DNC Systems: Types, advantages and its functions. Adaptive control systems.

NC/CNC Programming: NC Procedure, Manual programming, syntax formats in part programming, G & M codes, Cutter Radius Offset, Tool Length Offset, Fixed Cycles/canned cycles, Turning and milling programs.

UNIT-3 Computer Integrated Manufacturing System [11 hrs]

Computer integrated Manufacturing System: Introduction, Automation definition, Types of Automation, CIM processing in Manufacturing, Types of Production, Production Concepts & its Mathematical models, Problems on mathematical model, Automation Strategies.

High Volume Production system: Introduction, Automated flow line, Work part transport, Transfer Mechanism, Buffer storage and its control functions, Automation for machining operations.

UNIT-4 Analysis of Automated Flow Line [12 hrs]

Analysis of Automated Flow line: General terminology and analysis, Analysis of Transfer line with and without storage with numerical problems, Partial automation with numerical problems.

Assembly and Line balancing: Manual Assembly lines, Types of automated assembly system. Minimum rational work element, cycle time. Precedence constraints and diagram, Balance delay. Methods of Line balancing – Largest candidate rule, Kilbridge and Westers method, RPW method and numerical problems.

Text Books:

1. M.P.Groover & Emory W.Zimmer, **CAD/CAM, Computer Aided Design and Manufacturing**, Pearson India, 2007 2nd edition.
2. Mikell P.Groover, **Automation, Production system & Computer Integrated Manufacturing**, Pearson India, 2007 2nd edition.

Reference Books:

1. Ibrahim Zeid, **CAD/CAM theory and practice** Tata McGraw hill.
2. P. RadhaKrishnan, S. Subramanyan & V. Raju, **CAD/CAM/CIM** New Age international Publishers , 2nd edition.
3. P. RadhaKrishnan, **Computer Numerical Control Machines and CAM** New Age international Publishers, 1st edition 2012.
4. P. N. Rao **CAD/CAM Principles and applications**, Tata McGraw hill.

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
B18ME5270	**Heat Transfer Lab**	HC	0	0	2	2	3
Prerequisites: Basic & Applied Thermodynamics, Fluid mechanics		Internal Assessment			Semester End Exam		
		20 Marks			30 Marks		

Course Objectives:

1. To learn the various modes of heat transfer
2. To know performance of the fins.
3. To understand the heat transfer by convection.
4. To learn the performance of the heat exchangers.
5. To study the unsteady heat transfer

Course Outcomes:

By the end of the course the student shall be able to

1. Define conduction, convection and radiation heat transfer.
2. Determine the heat transfer coefficient under various conditions.
3. Conduct the experiment to find the effectiveness of the fin.

4. Find out the radiation heat transfer properties.
5. Prepare the document based on the conduction of the experiment.

List of Experiments:

1. Determination of Thermal Conductivity of Metal rod.
2. Determination Overall heat transfer co-efficient of composite wall.
3. Determination of Effectiveness and efficiency of a Metallic fin.
4. Determination of Heat Transfer Coefficient for a free Convection on vertical and horizontal tube.
5. Determination of Heat Transfer Coefficient for a Forced Convention Flow through a Pipe.
6. Emissivity of a Surface.
7. Determination of Stefan Boltzmann Constant.
8. Determination of LMDT and Effectiveness for a Parallel Flow and Counter Flow Heat
9. Exchangers.
10. Experiment on Transient Conduction Heat Transfer.
11. Demonstration on Boiling of Liquid and Condensation of Vapour.

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
B18ME5280	**CIM and Automation Lab**	HC	0	0	2	2	3
Prerequisites: CAD/CAM/CIM		Internal Assessment			Semester End Exam		
		20 Marks			30 Marks		

Course Objectives:

1. To train the students with part programming concepts
2. Generation of manual part programming – CNC Turn and CNC mill
3. Generation of tool path and NC part program by using part Geometry.

Course Outcomes:

By the end of the course, the student shall be able to

1. Generate the part program for the given profile/part geometry – offline
2. Able to work on CNC machines.

List of Experiments:

CNC, Part Programming using CAM packages simulation of Turning, Drilling and milling operations. Simulations to be carried out using simulation packages like Master CAM, Edge CAM, Cadem , MTAB or any equivalent software. (Model should consist of Minimum 4 operations).

DEMO of Flexible Manufacturing system, ASRS, AGVS Robot Programming, Hydraulic and pneumatic, basics of these topics to be conducted.

Reference: Manual prepared by REVA University Faculty.

Note: *Students should write the manual part programming in the observation book by using machine language codes and after the simulation of the cutter tool path , the students should take the print out of that profile & program and at the end should submit the soft bind report.*

SIXTH SEMESTER

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
B18ME6010	**Design of Transmission Elements**	HC	3	1	0	4	5
Prerequisites: Design of Machine Elements		Internal Assessment			Semester End Exam		
		40 Marks			60 Marks		

Course Objectives:

1. To teach the design of curved beams and flexible machine elements in engineering applications.
2. To carry out the design of clutches, brakes and springs
3. To teach the design of gears such as spur and helical
4. To teach the design of gears such as bevel and worm.

Course Outcomes:

By the end of the course the student shall be able to

1. Design the belts, chains, ropes and determine stresses in curved beams.
2. Design the different type's clutches, brakes and springs.
3. Design and analyze the strength, dynamic and wear loads on spur and helical gears
4. Design and analyze the strength, dynamic, wear loads and efficiency on bevel and worm gears.

Course Content:

UNIT- 1 Design of Flexible Drives and Curved Beams [12 hrs]

Design of Belt, Ropes and chain drives: : Introduction to transmission systems, Belt drive, design of flat and V- belts, Rope drives-selection of wire ropes, Chain drives- Design of Roller chains.

Curved Beams: Stresses in curved beams of standard cross sections used in crane hook, punching presses & clamps and S-link.

UNIT- 2 Power Transmission Elements [11 hrs]

Clutches & Brakes: Design of Clutches: Single plate, multi plate and Cone clutches. Design of Brakes: Block and Band brakes, self locking of brakes, Heat generation in Brakes.

Springs: Types of springs - Energy stored in springs, stresses in helical coil springs of circular and non-circular cross sections. Tension and compression springs, Leaf Springs, Stresses in leaf springs.

UNIT-3 Design of Parallel Gears [11 hrs]

Spur Gears: Introduction, stresses in gear tooth: Lewis equation and form factor, Design for strength, Dynamic load and wear load.

Helical Gears: Introduction, formative number of teeth, Design based on strength, dynamic and wear loads.

UNIT-4 Design of Non-Parallel Gears [11 hrs]

Bevel Gears: Introduction, formative number of teeth, Design based on strength, dynamic and wear loads.

Worm Gears: Introduction, Design based on strength, dynamic, wear loads and efficiency of worm gear drives.

Text Books:

1. V.B. Bhandari, **Design of Machine Elements**, Tata McGraw Hill Publishing Company Ltd., New Delhi.
2. R.S. Khurmi & J.K.Gupta, **Machine Design**, S. Chand Publications.

Reference Books:

1. Dr.P.C.Sharma & Dr.D.K.Aggarwal,**Machine Design**, S.K.Kataria and Sons, New Delhi.
2. Joseph E Shigley and Charles R. Mischke. **Mechanical Engineering Design**, McGraw Hill International edition, 6th Edition 2009.

Design Data Handbook:

1. **Design Data Hand Book**, K. Lingaiah, McGraw Hill, 2nd Ed.
2. **Data Hand Book**, K. Mahadevan and Balaveera Reddy, CBSPublication
3. **Design Data Hand Book**, H.G. Patil, I. K. International Publisher,2010.

Soft Core-4

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
B18ME6021	**Bio-Mass Energy System**	SC	3	0	0	3	3
Prerequisites: Engineering Thermodynamics ,Applied Thermodynamics		Internal Assessment			Semester End Exam		
		40 Marks			60 Marks		

Course Objectives:

1. Present an overview of biomass energy sources.
2. Introduce the various biomass conversion routes to bio fuels.
3. Present the harnessing technologies of biomass energy sources for power generation.
4. Present the applications, problems encountered in harnessing biomass energy sources for domestic and industrial uses.
5. Present the extraction process of biodiesel and its use in IC engines.

Course Outcomes:

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

1. Describe the fundamentals and characteristics of biomass energy sources.
2. Explain the technological basis for production of bio fuels from various biomass energy sources.
3. Explain the fundamental thermodynamic cycles and harnessing techniques of biomass energy sources for power generation
4. Explain the different types of biomass gasifiers and digesters.
5. Examine the performance of biodiesel in IC engine with its extraction.

Course Content:

UNIT–1 Bio mass and Biomass Conversion Method-I [11 hrs]

Introduction: Biomass energy sources, Origin of Biomass- photo synthesis process, photosynthetic efficiency, Energy plantation, Biomass Characteristics, Sustainability of biomass.

Biomass Conversion method I: Overview of biomass conversion methods-Physical, Agrochemical methods of fuel extraction-flowchart and explanation.
Self-Study: Rural and Urban waste to energy conversion.

UNIT–2 Biomass Conversion Methods-II and Biogas Generation [11 hrs]

Biomass Conversion method II: Thermo-chemical, Biochemical methods of biomass conversion - flowchart and explanation, domestic cooking & heating.
Biogas generation: Basic principles of anaerobic digestion, factors affecting biogas yield, biogas digester floating gas holder and fixed dome type with working principle and diagram, calculations for sizing biogas plant.
Self-Study: Survey on biogas production in India.

UNIT–3 Biomass Gasification and Ethanol for Power Generation [11 hrs]

Biomass Gasification: Chemical reaction in gasification, Types of gasifiers, Fixed bed gasifiers & Fluidized bed gasifiers -working principle with diagram, Liquefaction: Liquefaction through pyrolysis & Methanol synthesis, Producer gas: Constituents &application of producer gas in IC engines.
Ethanol for power generation: Ethanol production -sugarcane, starch & lignocellulosic materials, Ethanol as an automobile fuel & its use in engines.
Self-Study: Ethanol production and its usage in India.

UNIT–4 Bio–Diesel and Bio Power Plants [12 hrs]

Bio – Diesel: Sources, Production of bio diesel from non-edible oils, Blending of Bio diesel, Performance and emission characteristics of diesel engines using bio diesel. Effect of use of bio diesel in I C engines.
Bio Power Plants: Bio Power generation routes, Basic Thermodynamic cycles in Bio power Generation; Brayton cycle, Sterling cycle, Rankine cycle, Co-generation cycle. Biomass based steam power plant.

Text Books:

1. B.T. Nijaguna. **Bio Gas Technology,** New Age International- New Delhi.2001-02
2. G. D. Rai **Non Conventional Energy Sources,**– Khanna Publishers. Delhi.

Reference Books:

1. John.W.Twidell, Anthony. D. Weir, **Renewable Energy Resources,** EC BG-2001.
2. B H Khan **Non-conventional Resources**, TMH – 2007
3. S. Rao & B. B. Parulekar – **Energy Technology,** Khanna Publishers, Delhi-1999

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
B18ME6022	**Mechanics of Composite Materials**	SC	3	0	0	3	3
Prerequisites: SOM, Composites Materials, Advance Materials.		Internal Assessment			Semester End Exam		
		40 Marks			60 Marks		

Course Objectives:

1. To teach the students to introduction of composite materials
2. To perform micromechanical and macro mechanical analysis of a lamina.
3. To introduce to various biaxial strength theories and macro mechanical analysis of a laminate.
4. To provide a detailed knowledge of Strength Theories & analyze the macro mechanical analysis of laminate.
5. To provide thorough knowledge on coefficient of thermal expansion and other thermal properties of laminates.

Course Outcomes:

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

1. Describe the materials used for composites.
2. Analyze the micro/macro mechanical behavior of lamina
3. Describe the various biaxial strength theories and analyses macro mechanical analysis of a laminate.
4. Determine the coefficient of thermal expansion and other thermal properties of laminates

Course Content:

UNIT–1 Introduction to Composite Materials [11 hrs]

Definition-Matrix materials-polymers-metals-ceramics - Reinforcements: Particles, whiskers, inorganic fibers, metal filaments- ceramic fibers- fiber fabrication- natural composite wood, Jute - Advantages and drawbacks of composites over monolithic materials. Mechanical properties and applications of composites, Particulate-Reinforced composite Materials, Dispersion-Strengthened composite, Fiber-reinforced composites Rule of mixtures-Characteristics of fiber-Reinforced composites, Manufacturing fiber and composites

UNIT–2 Micro and Macro Mechanical Analysis of a Lamina [11 hrs]

Micro Mechanical Analysis of a Lamina: Introduction, Evaluation of the four elastic moduli by Rule of mixture.

Macro Mechanics of a Lamina: Hooke's law for different types of materials, Number of elastic Constants, Two – dimensional relationship of compliance and stiffness matrix Numerical.

UNIT–3 Strength Theories and Analysis [11 hrs]

Biaxial Strength Theories: Maximum stress theory, Maximum strain theory, Tsai-Hill theory, Tsai,

Biaxial Strength Theories: Maximum stress theory, Maximum strain theory, Numerical problems.

Macro Mechanical Analysis of Laminate: Introduction, code, Kirchhoff hypothesis, CLT, A, B, and D matrices, Special cases of laminates, Numerical**.**

UNIT–4 Thermal Analysis [12 hrs]

Assumption of Constant Co-efficient of Thermal Expansion (C.T.E.) - Modification of Hooke's Law. Modification of Laminate Constitutive Equations. Orthotropic Lamina C.T.E's. C.T.E's for special Laminate Configurations Unidirectional, Off-axis, Symmetric Balanced Laminates, Zero C.T.E laminates, Thermally Quasi-Isotropic Laminates.

Text Books:

1. K. K. Chawla **Composite Science and Engineering,** Springer Verlag 1998.
2. Autar K. Kaw **Mechanics of composite materials,** CRC Press New York.

Reference Books:

1. P. K. Mallick, **Fiber Reinforced Composites**,Marcel Dekker,Inc
2. Robert M. Jones, **Mechanics of Composite Materials**, McGraw Hill Kogakusha Ltd.1998
3. MeingSchwaitz," **Composite materials hand book**, McGraw Hill book company.1984
4. Ronald F. Gibron. **Principles of composite Material mechanics**, McGraw Hill international, 1994.
5. Madhujit Mukhopadhyay, **Mechanics of Composite Materials and Structures,** UniversitiesPress 2009.

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
B18ME6023	**Robotics**	SC	3	0	0	3	3
Prerequisites: CAD/CAM/CIM		Internal Assessment			Semester End Exam		
		40 Marks			60 Marks		

Course Objectives:

1. Identify the types of industrial robots.
2. Compute the concepts of robot representation using concepts of kinematics.
3. To attain knowledge about the uses & limitation of robotic applications.
4. To describe the basic methods & algorithms used in path planning for industrial robots.
5. To cultivate the ability to write robotics programs.

Course Outcomes:

By the end of the course student shall be able to

1. Identify the position and orientation of the object in space in a 3 dimensional space.
2. Describe the relationship between joint variables and the position and orientation of the robot end effectors
3. Elaborate the plan of trajectories for the robot end effectors to perform specific task
4. Apply the knowledge to design actual robots to perform basic operations such as pick & place line follower robots etc.

Course Content:

UNIT-1 Introduction to Industrial Robot [11 hrs]

Introduction: Fundamental laws of Robotics, Brief History of Robotics, Classification of Robots, Robot Evaluation- resolution, repeatability and accuracy of robot.

Components of Robots and Structure of Robots: Types of Joints, Representation of Joint, Degrees of Freedom and workspace

Configuration of Robots: RRR (Articulate), RRP (Spherical), RPP (Cylindrical), PPP (Cartesian)

UNIT-2 Kinematics of Robot and Transformations [11hrs]

Spatial Description: Description of position and orientation of a rigid body, Types of Frames, Euler angle representation for xyz, xyz frames.

Transformations: Translation, Rotation, Scaling (numerical with real applications), Homogeneous representation of Transformations, Properties of rotation matrices and combined transformations (numerical with real applications).

D-H Convention: Forward Kinematics, Implementation of D-H convention and obtaining transformation matrices for 3R Manipulator, SCARA Manipulator, PUMA 560 Manipulator. Inverse Kinematics, Inverse Kinematics of 3R Manipulator.

UNIT-3 Trajectory Planning and End Effectors [11 hrs]

Robot end effectors - Types of end effectors - Mechanical gripper – types of mechanical grippers – magnetic gripper – Vacuum gripper – Adhesive gripper – other special grippers.

Trajectory planning- Joint space scheme, Cubic trajectory- Joint space schemes with via points, Third order polynomial trajectory planning.

Robot Applications- Industrial and non industrial application, mobile application, limitations and future application of robot.

UNIT-4 Programming of Robots and Vision System [12 hrs]

Robot programming: Methods of Programming, Lead through Programming Methods, Three levels of Robot Programming – Teach by Showing, Explicit Robot Programming Language, Task Level Programming Language. Requirements of Robot Programming Language – World Modelling, Motion Specifications, Flow of Execution. Programming Environment, Sensor Integration, AML and VAL. Simple example, programming with graphics,

Machine vision system - Introduction to Machine vision – functional block diagram of machine vision system - Sensing and Digitizing – Image processing and analysis.

Text Book:

1. Saeed B. Niku, **Introduction to Robotics: Analysis, Systems, Applications**, 2nd edition, Pearson Education India, PHI 2003 (ISBN 81-7808-677-8)
2. Ganesh Hegde, **Industrial Robotics** University Science Press,2014

References Book:

1. M.P. Groover, **Industrial Robotics – Technology, Programming and Applications,** McGraw-Hill, USA, 1986.
2. Ramesh Jam, Rangachari Kasturi, Brain G. Schunck, **Machine Vision**, Tata McGraw-Hill, 1991.
3. Yoremkoren, **Robotics for Engineers**, McGraw-Hill, USA, 1987.
4. P.A. Janaki Raman, **Robotics and Image Processing**, Tata McGraw-Hill, 1991.

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.

B18ME6024	Theory of Plasticity	SC	3	0	0	3	3
Prerequisites: MOM,TOE		Internal Assessment			Semester End Exam		
		40 Marks			60 Marks		

Course Objectives:

1. To familiarize the review of Theory of elasticity.
2. To teach the Material Models and Stress-strain relations.
3. To analyze Plastic stress-strain relations.
4. To familiarize the students to the Stages of plastic yielding.
5. To teach the students knowledge of drawing, forging, rolling and extrusion.

Course Outcomes:

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

1. Demonstrate basic knowledge of Theory of Elasticity.
2. Develop the Material Models and Stress-strain relations.
3. Derive Plastic stress-strain relations.
4. Derive the equations for drawing, forging, rolling and extrusion.

Course Content:

UNIT–1 Introduction [12 hrs]

Brief review of elasticity, Octahedral normal and shear stresses, Spherical and deviatoric stresses, Invariance in terms of the deviatoric stresses, Idealised stress-strain diagrams for different material models, Engineering and natural strains, Mathematical relationships between true stress and true strains, Cubical dilation, Octahedral strain, Strain rate and the strain rate tensor.

UNIT–2 Material Models, Stress-Strain Relations [11 hrs]

Yield criteria for ductile material, Von Mises, Tresca, Yield surface for an Isotropic Plastic materials, Stress space, Experimental verification of Yield criteria, Yield criteria for an anisotropic material, flow rule normality, Yield locus, Symmetry convexity, Deformation of isotropic and kinematic hardening, deformation theory of plasticity.

UNIT–3 Plastic Stress-Strain Relations and Application [11 hrs]

Plastic stress-strain relations: Prandtl- Rouss, Saint Venant, Levy-Von Mises, Experimental verification of the Prandtl- Rouss equation

Application problems: Uniaxial tension and compression, Stages of plastic yielding. Bending of beams, Torsion of rods and tubes, nonlinear bending and torsion equations.

UNIT–4 Application of Metal Forming [11 hrs]

Extrusion, Drawing, Rolling and Forging, simple problems

Text Books:

1 R.A.C..Slater, **Engineering Plasticity-Theory and Application to Metal Forming Process** - McMillan Press Ltd., 1977.

2. Sadhu Singh, **Theory of Plasticity and Metal forming Process -** Khanna Publishers, Delhi, 1999.

Reference Books:

1. Haffman and Sachs**, Introduction to the Theory of Plasticity for Engineers**- LLC, 2012.
2. J Chakrabarty, **Theory of plasticity -** Butterworth, 2006.
3. Johnson and Mellor, **Plasticity for Mechanical Engineers -** Van Nostrand, 1966.

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
B18ME6025	**Machine Learning program using Python**	SC	2	0	1	3	4
Prerequisites: None		Internal Assessment			Semester End Exam		
		40 Marks			60 Marks		

Course Objectives:

1. To Describe the basic concepts of Python
2. To Identify the fundamental problems of machine learning
3. To Collect basic knowledge of the key algorithms and theory that form the foundation of machine learning
4. To Describe the techniques, mathematical concepts, and algorithms used in machine learning to facilitate further study in this area
5. To examine the limitations of various machine learning algorithms and the way to evaluate performance of machine learning algorithms.

Course Outcomes:

By the end of the course student shall be able to

1. Describe the basic concepts of Python and ML
2. Differentiate between different types of supervised learning.
3. Describe unsupervised learning.
4. Apply Reinforcement Learning to case studies.

UNIT –1 Python and Overview of ML [11 hrs]

Python: Origin, Programming Basics, data types and Operators, Program Files, Directories, Changing Data Through Names, Copying Data, Accessing a Tuple Through Another Tuple, packages and libraries. Overview of ML, broad categories of Machine learning- Supervised, Unsupervised, Semi-supervised, and Reinforcement Learning, Applications areas of Machine Learning. Examples and Case studies

UNIT –2 Supervised Learning [11 hrs]

Introduction, Classification and Linear Regression, k-Nearest Neighbor, Linear models, Decision Trees, Naive Bayes Classifiers, Kernelized Support Vector Machine (SVM) Algorithm. Neural Networks (deep learning), Comparison of different algorithms, discussions on case studies.

UNIT –3 Unsupervised Learning [11 hrs]

Introduction, types and challenges, preprocessing and scaling of datasets, Dimensionality reduction, feature extraction. Principal Component Analysis (PCA), k-means, agglomerative, and DBSCAN clustering algorithms. Comparison of different cluster algorithms, discussions on Case studies

UNIT –4 Reinforcement Learning **[12 hrs]**

Introduction, the learning task, Q learning –function, convergence, & updating sequence, rewards and actions, relationship to dynamic programming, discussions on Case studies.

Text Books:

1. Andreas C Muller & Sarah Guidp **Introduction of Machine Learning with Python** –O'Reilly & Shroff publishers
2. **Introducing Python**, Oriely Publications (chapters 1-6)
3. Tom M Mitchell **Machine Learning** – McGraw Hill Education publication – 2013

Reference Books:

1. Peter Flach **Machine Learning: The Art and Science of algorithms** — Cambridge University Press
2. Ethem Alpaydin **Machine Learning** – PHI learning private limited
3. David barber **Bayesian Reasoning and Machine Learning** - Cambridge University Press
4. Christopher Bishop, **Pattern Recognition and Machine Learning**, Springer, 2006
5. Olivier Chapelle, Bernhard Sch¨olkopf, and Alexander Zien **Semi-Supervised Learning** - The MIT Press Cambridge
6. Trevor Hastie, Robert Tibshirani and Jerome Friedman **The Elements of Statistical Learning** – Springer 2017 publication
7. Michael Dawson **Python Programming for absolute beginners**-3rd Edition
8. IEEE Transactions on **Artificial Intelligence & Machine Learning**
9. Journal of Machine Learning Research.

Soft Core-5

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
B18ME6031	**Refrigeration and Air conditioning**	SC	3	0	0	3	3
Prerequisites: Applied Thermodynamics		Internal Assessment			Semester End Exam		
		40 Marks			60 Marks		

Course Objectives:

1. To enable the students to gain knowledge of refrigeration and air conditioning.
2. To acquire the concept of refrigerants and their effects
3. To teach students the principles of psychrometry
4. To teach the students compute the cooling load for different applications of Refrigeration and Air-conditioning
5. To develop the knowledge of students in selecting the right equipment for a particular application of Refrigeration and Air-conditioning.
6. To expose the students to field of refrigeration and air conditioning, so that they can get an opportunity to work in R&AC industries.

Course Outcome:

By the end of the course the students shall be able to

1. Differentiate Actual system and ideal system

2. List and explain importance of the components used in vapor compression refrigeration system.
3. Calculate the amount of heat load and cooling requirement for general and simple application.
4. Explain the working of various devices used in general and commercial applications like water coolers, refrigerators, simple air conditioners and centralized system.
5. Apply the knowledge of this course in an industry and work with minimum risk..

Course Content:

UNIT -1 Refrigeration Cycles and System [11 hrs]

Methods of refrigeration, Brief discussion about Vapour compression refrigeration cycles and actual vapour compression cycle(detail discussion) Air refrigeration cycles(In brief)-Aircraft refrigeration system- various types- numerical on aircraft refrigeration system. Vapour absorption systems-COP of the system-Lithium bromide, three fluid vapour absorption systems, simple numerical.

UNIT-2 Refrigerants and Refrigeration Components [11 hrs]

Refrigerant classification–primary and secondary refrigerants. Designation—Detail discussion about selection of refrigerants, CFC'S, HCFC's and HFC's. Alternate refrigerants, Refrigerant absorbent combinations for vapor absorption system, Refrigerant compressors, Reciprocating, Rotary type, Condensers, Evaporators, Expansion devices, Low side-high side float, low pressure and high pressure cut outs, solenoid valves.

Self-Study: Global warming and Ozone depleting aspects.

UNIT -3 Psychrometry and Load Estimation [11 hrs]

Review of Moist air properties-various psychrometric process, Load estimation-comfort chart-SHF-GRSHF-ERSHF, cooling load estimate, heating load estimate, solar heat gain, infiltration, internal heat gain, Numerical on load estimation.

UNIT -4 Air-conditioning Equipments and Application of R and AC [12 hrs]

Package unit, central unit. Air distribution system- principles- air handling system, ducts and its arrangements, filters, fans, room air distribution- supply air outlets.

Food preservation-necessary-food freezing- various types, cold storage plants, Domestic refrigerator-construction and working and maintenance, Water coolers-storage type and pressure type, Dessert cooler, Window air conditioners, split air conditioners.

Self-Study: Design and installation of Centralized air conditioning system for Hospital/Hotel/commercial complex/Software company etc

Text Books:

1. S. C. Arora and Dumkundwar, , **Refrigeration and Air-Conditioning**, Dhanpathrai Publishers (1996)
2. R K Rajput "**Refrigeration and Air conditioning**" second edition, S K kataria and sons

Reference Books:

1. Manohar Prasad, **Refrigeration and Air conditioning**, Wiley Eastern Ltd. (1998)
2. Arora, C. P., **Refrigeration and Air Conditioning**, Tata McGraw-Hill Publishing Company Ltd. (2007)
3. W. F. Stocker and J. W. Jones, **Refrigeration and Air conditioning**, McGraw Hill. (2002)

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
B18ME6032	Experimental Stress Analysis	SC	3	0	0	3	3
Prerequisites: Mechanics of Materials, Design of Machine Elements. & TOE.		Internal Assessment			Semester End Exam		
		40 Marks			60 Marks		

Course Objectives:

1. To study the working principles of different types of strain gauges
2. To know the fundamentals of photo elastic coatings
3. To study the effects of 2-D& 3D photo elasticity
4. To study the stresses in 2-D & 3-D photo elastic materials by different techniques.
5. To be able to use the experimental techniques on the practical problems.

Course Outcomes:

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

1. Demonstrate the basics of experimental methods commonly used in real time problems.
2. Describe the Photo-Elasticity principles in Two Dimensional stress analysis.
3. Describe the three Dimensional Photo elasticity and analyses Bi-refrainment coatings.
4. Describe the behavior brittle Coatings and analyze Moire fringes

Course Content:

UNIT-1 Electrical Strain Gauges and Strain Rosettes [11 hrs]

Electrical Strain Gauges :Strain sensitivity in metallic alloys, Gage construction, Adhesives and mounting techniques, Gage sensitivity and gage factor, Performance Characteristics, Environmental effects, Strain Gage circuits. Potentiometer, Wheat stone's bridges.

Strain Rosettes: Two element, three element rectangular and delta rosettes, Correction for transverse strain effects, Stress gage, Plane shear gage, and Stress intensity factor gage.

UNIT -2 Photo-Elasticity and Two Dimensional Photo-elasticity [11 hrs]

Photo-Elasticity: Nature of light, Wave theory of light - optical interference, Stress optic law – effect of stressed model in plane and circular polariscopes, Isoclinics & Isochromatic, Fringe order determination Fringe multiplication techniques.

Two Dimensional Photo-elasticity: Separation methods: Shear difference method, Analytical separation methods, Model to prototype scaling, Properties of 2D photo-elastic model materials, materials for 2D photo elasticity.

UNIT-3 Three Dimensional Photo Elasticity and Photo-Elastic Coatings [11 hrs]

Three Dimensional Photo elasticity: Stress freezing method, Scattered light photoelasticity, Scattered light as an interior analyzer and polarizer, Scattered light Polari scope and stress data Analyses.

Photo-elastic (Bi-fringe) Coatings: Birefringence coating stresses, Effects of coating thickness: Reinforcing effects, Poisson's, Stress separation techniques: Oblique incidence, Strip coatings.

UNIT-4 Brittle Coatings and Moire Methods [12 hrs]

Brittle Coatings: Coatings stresses, Crack patterns, Refrigeration techniques, Load relaxation techniques, Crack detection methods, Types of brittle coatings, Calibration of coating. Advantages and brittle coating applications.

Moire Methods: Moire fringes produced by mechanical interference .Geometrical approach, Displacement field approach to Moire fringe analysis ,out of plane displacement measurements, Out of plane slope measurements .Applications and advantages.

Text Books:

1. Dally and Riley, **"Experimental Stress Analysis",** McGraw Hill.
2. Sadhu Singh, **"Experimental Stress Analysis".** Khanna publisher.
3. Srinath L.S **Experimental stress Analysis**, Tata McGraw Hill.

Reference Books:

1. M.M.Frocht **"Photoelasticity Vol I and Vol II**, , John Wiley &\ sons.
2. Perry and Lissner,**"Strain Gauge Primer",**
3. Kuske, Albrecht & Robertson **"Photo Elastic Stress Analysis",** John Wiley & Sons.
4. Dave and Adams,**"Motion Measurement and Stress Analysis",**

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
B18ME6033	**Statistical Quality Control**	SC	3	0	0	3	3
Prerequisites: Basic Mathematics		Internal Assessment			Semester End Exam		
		40 Marks			60 Marks		

Course Objectives:

1. To Introduce the concept of SQC and fundamentals of quality and its dimension
2. To introduce process control charts for variables and attributes
3. To provide knowledge of acceptance sampling plan and their application.
4. To introduce fundamentals of reliability and its improvement

Course Outcomes:

By the end of the course the students shall be able to

1. Evaluate process capability of a process
2. Prepare control charts for attributes and variables in process control.
3. Construct OC curves of sampling plans
4. Determine system reliability in different configuration.

Course Content:

UNIT -1 Introduction and Process Control for Variables [11 hrs]

Basic concept of quality, SQC, benefits and limitation of SQC, Quality assurance, Quality cost-Variation in process- factors – process capability

Process capability studies and Numerical – Theory of control chart- uses of control chart – Control chart for variables – X bar chart and R chart

UNIT -2 Process Control for Attributes [11 hrs]

Control chart for attributes –control chart for proportion or fraction defectives – p chart and np chart – control chart for defects – C and U charts, State of control and process out of control identification in charts. Numerical.

UNIT -3 Acceptance Sampling: [11hrs]

Lot by lot sampling – types – probability of acceptance in single, double, sequential sampling techniques – O.C. curves – producer's Risk and Consumer's Risk. AQL, LTPD, AOQL concepts and Numerical.

UNIT -4 Life Testing and Reliability [12 hrs]

Life testing – Objective – failure data analysis, Mean failure rate, mean time to failure, mean time between failure, hazard rate, system reliability, series, parallel and mixed configuration – simple problems. Maintainability and availability – numerical.

Reliability improvements – techniques- use of Pareto analysis – design for reliability – redundancy unit and standby redundancy – Optimization in reliability – Product design – Product analysis – Product development – Product life cycles.

Use of software tool for data analysis-hand's on.

Text Books:

1. Grant, Eugene .L **Statistical Quality Control**, McGraw-Hill, 7th Edition 2006.
2. L .S.Srinath, **Reliability Engineering**, Affiliated East west press, 4th Edition , 2009.

Reference Books:

1. Monohar Mahajan, **Statistical Quality Control**, Dhanpat Rai & Sons, 2001.
2. R.C.Gupta, **Statistical Quality control**, Khanna Publishers,6th Edition , 2003.
3. Besterfield D.H., **Quality Control**, Prentice Hall, 1993.
4. Sharma S.C., **Inspection Quality Control and Reliability**, Khanna Publishers, 2002.

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
B18ME6034	**Plant Layout and Material Handling**	SC	3	0	0	3	3
Prerequisites: None		Internal Assessment			Semester End Exam		
		40 Marks			60 Marks		

Course Objectives:

1. To introduce the concepts of facilities planning
2. To provide the knowledge of tools and techniques for developing layout
3. To Impart the knowledge of material handling system and its principles
4. To attain the concepts of plant maintenance.

Course Outcomes:

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

1. Create the design of a complex new facility of any kind.
2. Use different tools to develop alternative layouts
3. Solve the issues resulting from the movement of materials
4. Improving the efficiency of manufacturing or service systems by plant maintenance.

Course Content:

UNIT–1 Plant Location and Facilities [11 hrs]

Factors to be considered – influence of location on plant layout, selection of plant site, Consideration in facilities planning and layout. Equipments required for plant operation, Capacity, serviceability and flexibility and analysis in selection of equipments, space requirements and man power requirements. Need for layout, types of layout, factors influencing product, process. Fixed and combination layout

UNIT–2 Tools and Techniques for Developing Layout [11 hrs]

Process chart, flow diagram, string diagram, template and scale models – machine data. Layout planning procedure. Visualization of layout, revision and improving existing layout, balancing of fabrication and assembly lines. Quantitative techniques for analyzing material flow - with numerical

UNIT–3 Material Handling [11 hrs]

Principles of material handling. Planning, operating and costing Principles, types of material handling systems, factors influencing their choice, Unit load concept. Analysis of material handling - Motion analysis, flow analysis, graphic analysis, safety analysis, equipment cost analysis, palletization analysis, analysis of operation, material handling surveys.

UNIT–4 Plant Maintenance [12 hrs]

Role of maintenance management , Organization & systems of maintenance management , Different types of maintenance management , Their purpose and features, Preventive and Predictive maintenance techniques, Introduction to Total Productive Maintenance: Concepts, Tools and Procedure. Maintenance planning and scheduling using PERT networks (numerical)

Text Books:

1. S. C. Sharma, **Plant layout and material handling**, Khanna publishers.
2. Agarwal, **Plant layout and material handling**, Jain brothers publication.

Reference Books:

1. Shubin J A, **Plant layout,** P H I publications.1965
2. Oberman. Ya, **Material handling**, Mir publishers.1980
3. S.C. Sharma, **Material Management And Material Handling**, Khanna Publishers.1995
4. Maynard, H.B ed., **Industrial Engineering Hand Book** , McGraw hill

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
B18ME6035	**Artificial Intelligence**	SC	3	0	0	3	3
Prerequisites: None		Internal Assessment			Semester End Exam		
		40 Marks			60 Marks		

Course Objectives:

1. Familiarize with Artificial Intelligence principles and techniques
2. Introduce the facts and concepts of cognitive science by computational model and their applications.
3. Explore Expert Systems with Knowledge representation
4. Discuss on Heuristic search techniques & Intelligent Agents
5. Outline the fuzzy logic and parallel and distributed AI.

Course Outcomes:

By the end of the course student shall be able to

1. Analyze a problem, identify and define the computing requirements appropriate to its solution
2. Design a computer-based system, process, component, or program to meet desired needs
3. Select efficient algorithm to achieve optimized solution in complex situation
4. Apply heuristic methodologies in state-space problems
5. Characterize various ways to represent the environmental knowledge and to infer from it
6. Implement learning algorithms to apply and resolve in real world problems.

UNIT –1 Artificial Intelligence and Problems, Problem Spaces and Search [11hrs]

Artificial Intelligence: Definition**,** AI Problems-Task Domains of Artificial Intelligence; The Underlying Assumption - Physical Symbol System Hypothesis; AI technique - Knowledge properties, Knowledge Representation.

Problems, Problem Spaces and Search: Steps in building a System; Production Systems; Control Strategies-Requirements of a good control strategy; Problem Characteristics; Production System Characteristics-Categories of Production Systems.

UNIT–2 Heuristic Search Techniques and Knowledge Representation [11 hrs]

Heuristic search techniques: Generate-and-test, Hill Climbing-Simple Hill Climbing, Best First Search, Depth First Search-

Knowledge Representation: Introduction, Definition, Importance, Representation and Mappings-mappings between facts and representations, Representation of Facts; Approaches to Knowledge Representation.

UNIT–3 Learning [11 hrs]

Learning: Introduction, Different methods of Learning – Rote Learning, Inductive Learning, Reinforcement Learning, Unsupervised Learning, Supervised Learning, Analogy – Derivational and Transformational. **Expert Systems**: Introduction, Rule based and Knowledge based, knowledge acquisition.

UNIT–4 Parallel and Distributed AI and Fuzzy Logic Systems [12 hrs]

Parallel and Distributed AI: Psychological modeling; Parallelism in Reasoning Systems; Distributed Reasoning Systems. **Perception and Action:** A design for Autonomous Robot; Perception-Vision, Speech Recognition; Action-navigation, Manipulation.

Fuzzy Logic Systems: Introduction; Crisp Sets; Fuzzy Sets; Fuzzy Terminology.

Text Books:

1. Elaine Rich, Kevin Knight, Shivashankar B Nair, "**Artificial Intelligence**", 3rd Edition, Tata McGraw Hill, 2013.

Reference Books:

1. Jean-Louis Ermine,"**Expert Systems : Theory and Practice**",Prentice Hall of India, 1995
2. Stuart Russel, Peter Norvig,"**Artificial Intelligence: A Modern Approach**", 3rdPearson 3rd edition 2013.

Soft Core-6

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
B18ME6041	**Automotive Engineering**	SC	3	0	0	3	3
Prerequisites: Applied Thermodynamics		Internal Assessment			Semester End Exam		
		40 Marks			60 Marks		

Course Objectives:

1. To make the student understand about the various components of petrol engine and diesel engine.
2. To make the student understand about the various electrical components of an automobile necessary for Ignition system of an automobile.
3. To make the students understand the importance of emission control, alternate fuels and modifying the engine suitably.
4. To make students to recognize the need for safety and comfort that need to be invoked in the system.

Course Outcomes:

By the end of the course, the student shall be able to,

1. Describe; explain various aspects of automobile components and system which include engine components, fuel and ignition systems, transmission systems.
2. Demonstrate the various aspects of automobile components and suspension and braking systems and electrical and electronics system.
3. Describe the environmental implications of automobile emissions
4. Develop a strong base for understanding future developments in the automobile industry.

Course Content:

UNIT–1 Engine Components, Cooling and Lubrication [11 hrs]

Spark Ignition (SI) & Compression Ignition (CI) engines, cylinder – arrangements and their relatives merits, Liners, Piston, connecting rod, crankshaft, valves, valve actuating mechanisms, valve-Timing diagram, Types of combustion chambers for S.I.Engine and C.I.Engines, Compression ratio, methods of a

Swirl generation, choice of materials for different engine components, engine positioning, cooling requirements, methods of cooling, thermostat valves.
Self-study: different lubrication arrangements.

UNIT–2 Fuel Supply and Emission Control System [11 hrs]

Fuel Supply System: Fuel supply in SI engines- Fuel mixture requirements for SI engines, Working principle of simple carburetors, Injection systems -Single-point body injection, multipoint fuel injection, Inline distributor pump, Individual control pump, Common rail, Unit injection fuel transfer pumps, Fuel filters, fuel injection pumps and injectors.

Engine Emissions And Control Systems: Automotive emission controls, Controlling crankcase emissions, Controlling evaporative emissions, Cleaning the exhaust gas, Controlling the air-fuel mixture, Controlling the combustion process, Exhaust gas recirculation, Air-injection system, Air-aspirator system, Catalytic converter, low temperature combustion (LTC), homogeneous charge compression ignition (HCCI).

Self-study: Emission standards, premixed charge compression ignition (PCCI).

UNIT–3 Ignition System and Transmission System [11 hrs]

Ignition System, Superchargers And Turbochargers: Introduction, objectives, Ignition System Types, Comparison between Battery and Magneto Ignition System, Drawbacks (Disadvantages) of Conventional Ignition Systems, Advantages of Electronic Ignition System, Types of Electronic Ignition System, Firing Order, Importance of Ignition Timing and Ignition Advance. Naturally aspirated engines, Forced Induction, Types of superchargers, Turbocharger and comparisons.

Transmission System: General arrangement of clutch, Principle of friction clutches, Torque transmitted, Fluid flywheel, Single plate, multi-plate and centrifugal clutches. Gear box: Necessity for gear ratios in transmission. Self-study: synchromesh gear boxes.

UNIT–4 Suspension, Braking and Steering System [12 hrs]

Suspension, Springs And Brakes: Requirements, Torsion bar suspension systems, leaf spring, coil spring, independent suspension for front wheel and rear wheel. Air suspension system. Types of brakes, mechanical compressed air, vacuum and hydraulic braking systems, construction and working of master and wheel cylinder, brake shoe arrangements, Disk brakes, drum brakes, Antilock –Braking systems, purpose and operation of antilock-braking system, ABS Hydraulic Unit, Rear-wheel antilock

Steering System: Steering geometry, camber, king pin inclination, included angle, castor, toe in & toe out, condition for exact steering, steering gears, power steering, general arrangements of links and stub axle, over steer, under steer and neutral steer.

Text Books:

1. Kirpal Singh, **Automobile Engineering**, Volume 1&2, Standard Publications.
2. R. B. Guptha **Automobile Engineering,** Satya Prakashan ,New Delhi

Reference Books:

1. William.H.Crouse, (2006), **Automotive Mechanics**, 10th Edition, McGraw-Hill.
2. Mathur and Sharma **Internal Combustion Engines** Dhanpat Rai& sons- India.
3. V Ganesan (2006), **Internal Combustion Engines**, 12th Edition, McGraw-Hill.

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
B18ME6042	**Fracture Mechanics**	SC	3	0	0	3	3
Prerequisites: Mechanics of Materials		Internal Assessment			Semester End Exam		
		40 Marks			60 Marks		

Course Objectives:

1. To familiarize students to fracture mechanics principles
2. To understand Stress intensity factors and fracture toughness for different components.
3. To analyze concepts of LEFM and EPFM.
4. To understand the concept of dynamics and crack arrest.

Course Outcomes:

By the end of the course the student shall be able to

1. Describe fracture mechanics approach to design.
2. Select the proper nondestructive testing method to analyze a physical structure.
3. Demonstrate Fracture and Fatigue Control in Structures.
4. Describe the Dynamics and crack arrest in structures.

Course Content:

UNIT-1 Fracture Mechanics Principles and Airy Stress Function [12hrs]

Fracture mechanics principles: Introduction and historical review, Sources of micro and macro cracks. Stress concentration due to elliptical hole, Strength ideal materials, Griffith's energy balance approach. Fracture mechanics approach to design. NDT and Various NDT methods used in fracture mechanics, Numerical problems.

Airy stress function: The Airy stress function. Complex stress function. Solution to crack problems. Effect of finite size. Special cases, Elliptical cracks, Numerical.

UNIT–2 Plasticity Effects and Stress Intensity Factors [10 hrs]

Plasticity effects: Plasticity effects, Irwin plastic zone correction. Dugdale approach. The shape of the plastic zone for plane stress and plane strain cases, Plastic constraint factor. The Thickness effect, numerical.

Stress intensity factors: Determination of Stress intensity factors and plane strain fracture toughness: Introduction, analysis and numerical methods, experimental methods, estimation of stress intensity factors.

UNIT–3 Plane Strain Fracture and Elastic Plastic Fracture Mechanics [11 hrs]

Plane strain fracture: Plane strain fracture toughness test, The Standard test. Size requirements. Non-linearity. Applicability. The energy release rate, Criteria for crack growth. The crack resistance(R curve).Compliance, J integral. Tearing modulus. Stability

Elastic plastic fracture mechanics: Elastic plastic fracture mechanics: Fracture beyond general yield. The Crack-tip opening displacement. The Use of CTOD criteria. Experimental determination of CTOD .Parameters affecting the critical CTOD. Use of J integral. Limitation of J integral.

UNIT–4 Crack Arrest and Fatigue Crack Propagation [11 hrs]

Dynamics and crack arrest: Crack speed and kinetic energy. Dynamic stress intensity and elastic energy release rate. Crack branching. Principles of crack arrest. Crack arrest in practice. Dynamic fracture toughness.

Fatigue crack propagation: Fatigue crack propagation and applications of fracture mechanics: Crack growth and the stress intensity factor. Factors affecting crack propagation. Variable amplitude service loading, Means to provide fail-safety, Required information for fracture mechanics approach, Mixed mode (combined) loading and design criteria.

Text Books:

1. David Brock, **Elementary Engineering Fracture Mechanics** - Noordh off.
2. Anderson, T.L **Fracture Mechanics-Fundamental and Application** - CRC press1998.

Reference Books:

1. S.A. Meguid **Engineering fracture mechanics** - Elsevier.
2. Jayatilake, **Fracture of Engineering Brittle Materials**, Applied Science - London.
3. Rolfe and Barsom, **Fracture and Fatigue Control in Structures** -, Prentice Hall.
4. Karen Hellan, **Introduction to fracture mechanics** - McGraw Hill.
5. Knott, Butterworths. **Fundamentals of V fracture mechanisms** - Fracture –LiefbowitzVolime II.

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
B18ME6043	**Mechatronics and Microprocessor**	SC	3	0	0	3	3
Prerequisites: Basic Electronics		Internal Assessment			Semester End Exam		
		40 Marks			60 Marks		

Course Objectives:

1. To study the elements of measurement systems and appreciate its relevance in engineering design.
2. To impart knowledge about working & performance of widely used sensors and actuators, electrical actuation systems.
3. To attain knowledge of programming techniques involved in microprocessors and microcontrollers which are essential to understand the emerging field of automation.

Course Outcomes:

By the end of the course student shall be able to

1. Explain the basic elements of microprocessor based controller systems.
2. Describe the working and applications of sensors and transducers
3. Explore the actuation systems used for automation.
4. Acquire the knowledge of the basics, architecture and programming of microprocessor and microcontrollers.

Course Content:

UNIT -1 Transducers and Sensors [11 hrs]

Introduction: Measurement and control systems their elements and functions, Microprocessor based controllers, examples of Mechatronics systems, PLC, ladder diagrams.

Transducers and Sensors: Static and dynamic characteristics of sensor, Potentiometers-LVDT-Capacitance sensor-Strain gauges-Eddy current sensor-Hall effect sensor-Temperature sensors-Light sensors.

UNIT-2 Actuation System [11 hrs]

Actuation System: Electro mechanical switches, solid-stat switches, solenoids, Elements of mechanical actuation system.

Signal Conditioning: filtering, multiplexers, de multiplexers, ADC, DAC.

UNIT -3 Introduction to Microprocessors [11 hrs]

Microprocessors: Evolution of microprocessor, organization of microprocessor, basic concepts of programming of microprocessors. Boolean algebra, Logic gates & gate networks, Binary & Decimal number systems. Conversion of real numbers, overflow and underflow, addition of floating point numbers, character representation.

Logic functions: Data word representation, basic elements of control system, 8085A processor architecture, pin configuration, terminology-CPU, ALU, data registers, assembler, fetch cycle, bus,

interrupts. Micro controllers and its classification, difference between microprocessors and microcontrollers.

UNIT-4 Organization and Programming of Microprocessors [12 hrs]

Organization and Programming of Microprocessors: Introduction of INTEL 8085-Data and Address buses, Instruction set of 8085, programming the 8085, assembly language programming.

Central Processing Unit of Microprocessors: Introduction, timing and control unit basic concepts, Instruction and data flow, system timing, examples of INTEL 8085 and INTEL 4004 register organization.

Text Books:

1. W.Bolton **Mechatronics,**fourth edition, Pearson Publications, 2017.
2. R. S Ganokar, **Microprocessor Architecture, Programming and applications with 8085/8086A,**Wiley Eastern.
3. H D Ramachandra, **Mechatronics,** M/S Sudha Publications

Reference Books:

1. Devdas shetty and Richard A. Kolk **Mechatronics System Design,**.
2. Krishna Kant, **Microprocessors and Microcontrollers,** Prentice Hall of India, 2007.

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
B18ME6064	**Industrial Engineering**	SC	3	0	0	3	3
Prerequisites: None		Internal Assessment			Semester End Exam		
		40 Marks			60 Marks		

Course Objectives:

1. To provide knowledge of Industrial Engineering concepts, Application of Work study in the shop floor
2. To known the concepts of method study and work measurement with their relative technique.
3. To perform value analysis and work sampling for a job.
4. To determine the standard time for the specified job.
5. To determine different types of depreciation cost.

Course Outcomes:

By the end of the course the students shall be able to

1. Calculate productivity and explore ways for improving productivity
2. Evaluate layouts and location of plant
3. Conduct work study and method study
4. Perform value analysis and work sampling of a job
5. Calculate depreciation and replacement policy of machines.

Course Content:

UNIT-1 Plant Location and Layout [11 hrs]

Industrial Revolution and historic development of the factory system. Concept of Productivity, Various types of productivity, causes for lack of productivity and increase of work content. Production system and its types, Factors influencing plant location, theories of plant location, location economics, selection of specific site. Plant layout: Objectives of plant layout, principles of plant layout, types of plant layout, their merits and demerits, , Evaluation of Layouts

UNIT -2 Work Study and its Techniques [11 hrs]

Concept of work study, Basic procedure of work study. Concept of method study, Definition, selection, recording, examining, developing, installing and maintaining new method. Use of recording techniques such as outline process , flow process chart, multiple activity chart, flow diagram , String diagram, Travel chart. Principles of motion economy & Micro motion study.

Work Measurement: Common steps in work measurement, Time study method, breaking the task into work elements, types of elements, rating and different methods of rating. Allowances and its types. Calculation of basic time and standard time with numerical.

UNIT–3 Work Sampling and Value Engineering [11 hrs]

Work Sampling: Principles, Procedure, confidence limits, number of observations required, advantages and disadvantages, applications. Ergonomics: Human factors in the design of workplace, layout of equipment, design of displays and controls. Fatigue and measurement of fatigue.

Value Engineering: Value engineering- definition, kinds of value, key elements, value engineering job plan, life cycle cost and product life cycle.

UNIT-4 Equipment Replacement and Depreciation [12 hrs]

Equipment Replacement: Nature of replacement problems, economic life of challenger and defender, Replacement of items – individual replacement and group replacement .

Depreciation – Definition, factors, Types of Depreciation with numerical.

Text Books:

1. ILO(International Labor organization) **Introduction to Work study**,
2. O.P.Khanna, **Industrial Engineering and Economy** , PHI Publisher

Reference Books:

1. Maynard **Hand book of Industrial Engineering** ,
2. Ralph.M.Barnes,**Motion and Time Study**, John wiley.
3. Marvin.E.Mundel ,**Motion and Time Study** ,

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
B18ME6045	**Flexible Manufacturing System**	SC	3	0	0	3	3
Prerequisites: None		Internal Assessment			Semester End Exam		
		40 Marks			60 Marks		

Course Objectives:

1. Learn about the basic introduction of FMS.
2. Detailed study of Flexible Manufacturing Cell & machining center
3. Helps to learn the tool management in FMS for machining product variety

Course Outcomes:

By the end of the course student shall be able to

1. Classify and distinguish FMS and other manufacturing systems.
2. Differentiate Turning & Machining Centers.
3. Explain Coordinate Measuring Machines.
4. Describe various types of AGVS
5. Explain material handling system used in FMS environment
6. Understand tool managements in FMS.

Course Content:

UNIT–1 Introduction of FMS [11 hrs]

Description, Need, Basic Component, Significance, General layout and configuration, Objectives, Benefits and limitations, Area of Application of a FMS in Industry, Various Hardware and Software required for an FMS, CIM Technology, Hierarchy of CIM, FMS Justification.

UNIT–2 Manufacturing Cell , Turning and Machining Centers [11 hrs]

Manufacturing Cell: Introduction, Classifications of Cell, Unattended Machining, Cellular versus Flexible Manufacturing.

Turning and Machining Centers: Introduction, Types ,Construction and Operation Performed on Turning Center, Automated Features and Capabilities of Turning Centers, General Advantages and Disadvantages of Vertical and Horizontal Machining Centers, Pallet and Part Loading and Programming Options in Machining Centers, Automated features and capabilities of a Machining Centers.

UNIT–3 Cleaning and Deburring Equipment, Coordinate Measuring Machines [11 hrs]

Cleaning and Deburring Equipment: Wash Station and Operation Description, Deburring Station and Operation Description, Importance of Cleaning and Deburring in Automated Manufacturing.

Coordinate Measuring Machines: Introduction, Types, Construction and General Functions of CMM, Operational Cycle Description, CMM Applications, Importance to Flexible Cells and Systems.

UNIT–4 Automated Material Movement and Storage, Management Technology [12 hrs]

Automated Material Movement and Storage System: Introduction, Types of AGV and Their principle of working, Advantages, Limitation and General AGV Guide path, Robots, Benefits of using Industrial Robots, Basic components and benefits of Automated Storage and Retrieval Systems, Conveyors and Pallet Flotation System, Queuing Carrousels and Automatic Work Changers, Coolant and Chip Disposal and Recovery system.

Management Technology: Tool Management, tool magazine, Tool preset, identification, Tool monitoring and fault detection, routing, Production Planning and Control, Scheduling and loading of FMS

Text Books:

1. Groover M.P, **Automation, Production Systems and Computer Integrated Manufacturing** Prentice Hall of India.
2. H. K. Shivanand, M. M. Benal, V. Koti, **Flexible Manufacturing System** New Age Pub.

Reference Books:

1. David J.Parrish, "**Flexible Manufacturing**" Butterworth-Heinemann, 1990.
2. Groover M.P, Zimmers E.W, **CAD/CAM** – Prentice Hall of India.
3. Nanua Singh, **Approach to Computer Integrated Design and Manufacturing** John Wiley and Sons, 1998.
4. Vajpayee, **Principles of CIM** PHI.

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
B18ME6150	**Dynamics of Machines**	HC	3	1	0	4	5
Prerequisites: KOM, MOM		Internal Assessment			Semester End Exam		
		40 Marks			60 Marks		

Course Objectives:

1. To explain the equilibrium conditions, static and dynamic force analysis for different mechanisms and to draw the turning moment diagram of flywheel
2. To explain the analytical approach and graphical methods (force and couple polygon) in balancing the unbalanced rotating and reciprocating engines.
3. To explain the application of governors in controlling the mean speed of an engine and belt drives
4. To introduce the concept of gyroscopic effect in analyzing the stability of disc, two wheeler, four wheeler, ships and aero planes.

Course Outcomes:

By the end of the course student shall be able to

1. Describe the condition for equilibrium of member under the action of forces, draw the free body diagram & analyze the static forces on slider crank mechanism, four bar mechanism and determination of size of flywheels.
2. Apply the analytical approach and graphical methods (force and couple polygon) in balancing the unbalanced rotating and reciprocating engines.
3. Determine the mean speed and performance parameters of governors and compute the ratio, centrifugal tension and power of belt drives.
4. Analyze the gyroscopic effect on aero plane, naval ships and in automobiles.

Course Content:

UNIT-1 Static, Dynamic Force Analysis and Flywheel [11hrs]

Static & Dynamic Force Analysis: Introduction, Static equilibrium. Equilibrium of two and three force members. Members with two forces and torque. Free body diagrams. Static force analysis of four bar mechanism and slider-crank mechanism with and without friction. Principle of virtual work. D'Alembert's principle and its application.

Flywheel: Turning moment diagrams and flywheels. Fluctuation of Energy. Determination of size of flywheels.

UNIT-2: Balancing of Rotating Masses and Reciprocating Masses [11hrs]

Balancing of Rotating Masses: Static and dynamic balancing. Balancing of several rotating masses by balancing masses in same plane and in different planes.

Balancing of Reciprocating Masses: Balancing of primary force in reciprocating engine, partial balancing of multi cylinder locomotives inline engine and V- engine. Numerical.

UNIT-3: Governors and Belt Drives [13hrs]

Governors: Introduction, principles, Types of governors, Terminology, force analysis of Porter and Hartnell governors, sensitivity, stability, Hunting, Isochronism, effort and power of governor, controlling force diagram. Numerical.

Belt drives: Flat belt drives, ratio of belt tension, centrifugal tension, power transmission.

UNIT-4: Gyroscopic Motion [10 hrs]

Principles, Gyroscopic Torque, effect of gyroscopic couple on the stability of disc, aero plane, ship, Two wheeler and four wheeler.

Text Books:

1. S.S. Rattan, **Theory of Machines**, Tata McGraw Hill Publishing Company Ltd., New Delhi, 3rd edition, 2013.
2. R K Bansal, **Theory of Machines**- 6th edition, Laxmi Publications.
3. R S Khurmi & J K Gupta, **Theory of Machines**, 5th edition, S. Chand Publications.

Reference Books:

1. Dr. Sadhu singh, **Kinematics of Machines**-2nd edition, Pearson publication.
2. Thomas Bevan, **Theory of Machines**- 3rd edition, CBS Publication.
3. Shigley, **Theory of Machines**- 3rd edition McGraw hill Book Company.

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
B18ME6160	**Metal Forming Process**	HC	3	0	0	3	3
Prerequisites: Manufacturing Technology		Internal Assessment			Semester End Exam		
		40 Marks			60 Marks		

Course Objectives:

1. The course will enable the students to acquire a fundamental knowledge on metal forming technology which is necessary for an understanding of industrial processes.
2. To introduce students to the wide range of materials and processes, which are currently used in manufacturing industry?
3. The course will also provide methods of analysis allowing a mathematical/physical description of forming processes.
4. The course will enable the students to identify the processes characteristics, select the main operator parameters, the tool geometry and materials, and determine forces and power required to select the main and auxiliary equipment.

Course Outcomes:

By the end of the course students shall be able to

1. The students should learn and understand necessity of forming process compared with other manufacturing techniques
2. The learning of various methods of forming gives an idea for the selection of a process for different materials
3. The students should know the parameters effect on the processing of the wrought products.
4. Students should be able to select the process, load required and possible reasons for the formation defects of the forged components
5. The students should have the knowledge to identify and analyze production of wire, rod , tubes using different processes and problems occurred in the process

Course Content:

UNIT-1: Introduction [11 hrs]

Classification of metal forming processes, Hot working and cold working , advantages and limitations of metal working processes. Concepts of true stress and true strain, Relationship between conventional and true strain. Variables in Metal forming**:** Temperature in metal forming, strain rate or Deformation velocity, Grain size and microstructure, Friction in metal forming, Lubrication in metal forming, Formability of materials, Deformation zone geometry, hydrostatic pressure, Residual stresses in metal working.

UNIT- 2: Forging and Rolling [11 hrs]

Classification of Metal Forming Processes, Hot working and cold working of metals

Forging: classification of forging processes – Open, impression and closed die forging, Typical forging operations, forging defects, advantages and disadvantages of forging, Simple problems on forging load calculations.

Rolling: classification of rolling process, rolling mills, rolling variable and defects in rolled parts, Simple problems on rolling load.

UNIT -3: Drawing and Extrusion [11 hrs]

Drawing: Principle of rod and wire drawing, Tube drawing and its classification, Simple problems.

Extrusion: Types of extrusion processes, Extrusion of seamless tubes and defects in extrusion, Simple problems on extrusion.

UNIT -4: Sheet Metal and High Energy Rate Forming [12 hrs]

Sheet metal forming methods, Dies and punches, Rubber forming. Stretch forming, LDR in drawing, defects in deep drawn products, piercing, blanking, bending, deep drawing, stretch forming, simple problems.

High Energy Rate Forming Methods and Powder Metallurgy: Introduction , Principles, advantages and applications, explosive forming, electro hydraulic forming, Electromagnetic

forming. Basic steps in Powder metallurgy , application of powder metallurgy components, advantages and limitations.

Text Books:

1. G.E. Dieter, **Mechanical Metallurgy** (SI units), Mc Graw Hill pub.2001
2. Dr. K.Radhakrishna, **Manufacturing Process – III**, Sapna Book House, 2009.

Reference Books:

1. E.paul, Degramo, J.T. Black, Ronald, A.K. **Materials and Processes in Manufacturing**, Prentice -hall of India 2002
2. G.W. Rowe, **Principles of Industrial metal working process**, CB Spub. 2002
3. Amitabha Ghosh & A.K. Malik - **Manufacturing Science,** East – West press 2001
4. Surendrakumar, **Technology of Metal Forming Process**, PHI –2008.

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
B18ME6170	**Internal Combustion Engines Lab**	HC	0	0	2	2	3
Prerequisites: Applied Thermodynamics		Internal Assessment			Semester End Exam		
		20 Marks			30 Marks		

Course Objectives:

1. To learn the various methods used for testing of IC engines..
2. To know performance of the engines and different loads.
3. To know the various heat losses by drawing heat balance sheet.
4. To learn the performance of the compressor and blower
5. To study the performance of the refrigerator and air-conditioner.

Course Out comes:

By the end of the course the student shall be able to

1. Define IC terminology like IP, BP, SFC, BSFC, ISFC.
2. Determine the BP, IP, efficiency of the engines under various loads.
3. Find out the COP of the refrigeration and air conditioning test rig.
4. Prepare the document of the experimental work.

List of Experiments:

1. Determination of area of regular and irregular surface Using Planimeter.
2. Draw the Valve timing diagram of four stroke diesel engine.
3. Conduct performance test on single cylinder two stroke petrol engine.
4. Conduct performance test on single cylinder four stroke petrol engine.
5. Conduct performance test on single cylinder four stroke diesel engine.
6. Determination of frictional power of multi cylinder petrol engine using Morse test.
7. Determination the effect of variable compression ratio on four stoke single cylinder VCR petrol engine
8. Determination of volumetric efficiency and overall efficiency of two stage air compressor
9. Conduct performance to determine the overall efficiency of air Blower
10. Determination of relative COP of Vapour Compression Refrigeration system
11. Conduct the performance test on Vapour compression air condition system

Demo Experiments

1. Preparation of Biodiesel from vegetable oil (edible and non edible) and animal fat by transesterification process.
2. Measurement of emissions such as HC,CO,CO_2,$O_2$and NOx from the exhaust of diesel engine with the help of five gas exhaust gas analyser (AVL 440)
3. Measurement of smoke from the exhaust of diesel engine by AVL smoke meter.

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
B18ME6180	**Design and Dynamics Lab**	HC	0	0	2	2	3
Prerequisites: DOM and ESA		Internal Assessment			Semester End Exam		
		20 Marks			30 Marks		

Course Objectives:

1. To learn the testing procedure in design field.
2. To know the frequency of the rotating objects
3. To know the stress and strain in the component when it undergoes various types of loads.
4. To understand the stress concentration in the elements.
5. To learn the use of strain gages and its working principle

Course Outcomes:

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

1. Define frequency, critical speed and terminologies used in the dynamics of machines.
2. Determine the stresses and strains in the components.
3. Analyze the equilibrium speed, sensitiveness, power and effort of governors.
4. Define stress concentration and its importance and determine the stress concentration factor.
5.

List of Experiments:

PART – A

1. Determination of natural frequency, logarithmic decrement, damping ratio and damping coefficient in a single degree of freedom vibrating systems (longitudinal and torsional)
2. Determination of critical speed of a rotating shaft.
3. Determination of Fringe constant of Photo elastic material using.
    a. Circular disc subjected to diametrical compression.
    b. Pure bending specimen (four point bending)
4. Balancing of rotating masses.
5. Determination of Principal Stresses and strains in a member subjected to combined
    a. Loading using Strain rosettes.
6. Determination of pressure distribution in journal bearings
7. Determination of equilibrium speed, sensitiveness , power and effort of porter governor
8. Experiment on Gyroscope (demonstration only)

PART – B

1. Introduction to MATLAB- Capabilities, Commands and creating m-files.
2. Variations of the natural frequency and the time period with static deflection of an undamped system.
3. Free-Vibration Response of a Spring-Mass System.
4. Unforced Response Spring Mass Damper System.
5. Simulation of Simple Pendulum.
6. Simulation of Three Bar Linkage Mechanism.

Details of the Exercises:

A. Plot the variations of the natural frequency and the time period with static deflection of an undamped system using MATLAB for deflection range of 0 to 0.5 cm

1. A spring-mass system of 20 kg with a mass of and stiffness 500 N/m is subject to an initial displacement of x_0 = 30 mm and an initial velocity of 40 mm/sec Plot the time variations of the mass s displacement, velocity, and acceleration using MATLAB.
2. Solve for five cycles, the response of an unforced system given by the equation $m\,x'' + c\,x' + kx = 0$, For $\xi = 0.1$; m = 1 kg; k = 100 N/m; x (0) = 0.02 m; $x'(0) = 0$;
3. Compute and plot the linear response of a simple pendulum having a mass of 10 grams and a length of 5 cms. The initial conditions are $\theta(0) = 90^0$ and $(\theta)' 0 = 0$. Also compare the generated plot with the nonlinear plot.
4. For the three-bar-linkage mechanism ,for a constant rotation rate ω of link L1, determine and plot the angular displacements of links L2 and L3 for one cycle of rotation of L1. Choose L1, L2 and L3 as 0.35m, 1m and 1m respectively Also choose ‘a’ and ‘b’ as 0.6m and 0.4m respectively. The angular velocity, ω of linkL1 is chosen to be 3 rad/sec

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
B18ME6250	**Heat Transfer**	HC	3	1	0	4	5
Prerequisites: Engineering Thermodynamics, Fluid Mechanics and Machinery		Internal Assessment			Semester End Exam		
		40 Marks			60 Marks		

Course Objectives:

1. Introduce the basic principles and laws governing the heat transfer.
2. Identify and compare the various modes of heat transfer, combined heat transfer processes and special heat transfer processes.
3. Provide a strong foundation for analysis of complex heat transfer problems and special heat transfer process using heat transfer data hand book.
4. Present a strong foundation to design heat exchangers, analyze boiling and condensation process using heat transfer data hand book.
5. Introduce various terms, laws of radiation heat transfer and to compute radiation exchange.

Course Outcomes:

By the end of the course student shall be able to

1. Define heat transfer and compare the three modes of heat transfer.
2. Identify different thermal processes, and derive the basic expressions for heat conduction, convection and radiation based on the First Law of Thermodynamics.
3. Analyze heat transfer problems using electrical resistance network analogy.
4. Discuss and analyze the applications of heat transfer problems using fins and critical thickness of insulation.
5. Analyze transient conduction problems using LSA and charts.
6. Define laws of radiation heat transfer; evaluate the radiation exchange between two finite and infinite surfaces.

Course Content:

UNIT -1: Introduction and Conductive Heat Transfer I [11 hrs]

Introduction to Heat transfer: Modes of heat transfer, basic laws of heat transfer, Initial conditions and boundary conditions, Thermal contact resistance, Overall heat transfer coefficient, 3-D heat conduction equation in Cartesian co-ordinates, Discussion on 3-D conduction equation in Cylindrical & Spherical coordinates, Discussion on 1-D steady state heat conduction without heat generation (plane wall, cylinders & spheres), Heat transfer through composite wall and numerical.

Conductive Heat transfer I: Critical thickness of insulation on spheres and cylinders, Fins-types of fins, Discussion on governing equations for different conditions of fins, effectiveness & efficiency of fin, Numerical.

UNIT -2: Conductive Heat Transfer II and Convective Heat Transfer I [11 hrs]

Conductive Heat transfer II (1-D Transient Conduction): Lumped system Analysis, Use of Heisler's charts for transient conduction in plane slab, long cylinder and sphere. Numerical examples.

Convective Heat transfer I: Concepts and basic relations in boundary layers: Hydrodynamic and thermal boundary layer over a flat plate, critical Reynolds number, Local heat transfer coefficient, average heat transfer coefficient, internal flow through duct, Numerical. .

Free or Natural Convection: Applications of dimensional analysis for free convection, physical significance of Grashoff number, Use of correlations for free convection of plates, cylinders, spheres, Numerical.

UNIT -3: Convective Heat Transfer II and Radiation Heat Transfer [11 hrs]

Convective Heat transfer II: Forced Convection- Applications of dimensional analysis for forced convection, physical significance of Reynolds, Prandtl, Stanton, Nusselt numbers, Use of correlations for hydro dynamically and thermally developed flows in case of internal and external flows ,laminar and turbulent flow solutions .

Radiation Heat transfer: Thermal radiation, definitions of various terms, Laws of black body radiation-Stefan Boltzmann , Weins displacement law, Kirchoff's law, Planck's law, Black body concept, Discussion on radiation shape factor, Discussion on heat exchange between two gray bodies(Infinite parallel planes),Discussion on effect of radiation shields, Numerical.

UNIT -4: Heat Exchangers and Phase Change Convective Process [12 hrs]

Heat Exchangers: Classification, Overall heat transfer coefficient, fouling and fouling factors, LMTD, Discussion on effectiveness-NTU methods of analysis of heat exchangers, Numerical.

Phase Change Convective Process: Condensation, Use of condensation correlations for flat vertical plate, horizontal tube and tube banks, Reynolds number for condensate flow.

Boiling-types of boiling, Regimes of pool boiling, Pool boiling correlations, Numerical.

Text books:

1. Tirumaleshwar, **Heat & Mass transfer**, Pearson education 2006
2. Ozisik, **Heat transfer-A basic approach**, Tata McGraw Hill 2002.

Reference books:

1. Yunus A-Cengel, **Heat transfer-A practical approach,** Tata McGraw hill.
2. Mahesh M Rathore, **Heat and mass transfer,** Laxmi publications.
3. Kreith **Principles of Heat transfer,** Thomas Learning 2001
4. Frenk P.Incropera and DavidP.Dewitt, **Fundamentals of heat and mass transfer**, John Wiley and son's.
5. R K Rajput , **Heat and Mass transfer,** S Chand Publications**.**

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
B18ME6260	**CAD/CAM/CIM**	HC	3	0	0	3	3
Prerequisites: Theory of metal cutting & machine tool		Internal Assessment			Semester End Exam		
		40 Marks			60 Marks		

Course Objectives:

1. To obtain the fundamentals of CAD/ CAM / CIM and related concepts to understand the various modeling features and its manufacturing.
2. Interpret various concepts of CAD /CAM /CIM, the product development cycle can be reduced in the design stages and also reduction of Manufacturing Lead time.
3. Developing the NC programming and its importance in practical applications by using coding system.
4. To have a hands on experience on various tools used for modeling and manufacturing aspects.

5. To study about the line balancing in automated flow lines.

Course Outcomes:

By the end of the course student shall be able to

1. Analyze the basic principles of CAD & CAM in engineering applications.
2. Create geometric models of components by using software and generation of part programming by using machine language codes.
3. Reduction of Manufacturing Lead time and Product development time.
4. Evaluate the performance of automated flow lines.

Course Content:

UNIT - 1 Fundamentals of CAD [11 hrs]

Fundamentals of CAD: Definition of CAD/CAM, Product cycle and its cad / cam over laid, Design process & application of computers for design, creating the manufacturing database, Benefits and achievement of CAD.

Computer Graphics: Raster Scan Graphics, Coordinate Systems, Database Structure for Graphic Modeling, functions of graphics package, Transformation of geometry, 2D transformations – Simple problems. Geometric Modeling: Curve Representation, Surface Representation methods.

UNIT -2 Introduction to NC Technology [11 hrs]

NC Technology: Basic components of NC system, NC Coordinate system, types of NC motion control systems, advantages and applications of NC. CNC & DNC Systems: Types, advantages and its functions. Adaptive control systems.

NC/CNC Programming: NC Procedure, Manual programming, syntax formats in part programming, G & M codes, Cutter Radius Offset, Tool Length Offset, Fixed Cycles/canned cycles, Turning and milling programs.

UNIT-3 Computer Integrated Manufacturing System [11 hrs]

Computer integrated Manufacturing System: Introduction, Automation definition, Types of Automation, CIM processing in Manufacturing, Types of Production, Production Concepts & its Mathematical models, Problems on mathematical model, Automation Strategies.

High Volume Production system: Introduction, Automated flow line, Work part transport, Transfer Mechanism, Buffer storage and its control functions, Automation for machining operations.

UNIT-4 Analysis of Automated Flow Line [12 hrs]

Analysis of Automated Flow line: General terminology and analysis, Analysis of Transfer line with and without storage with numerical problems, Partial automation with numerical problems.

Assembly and Line balancing: Manual Assembly lines, Types of automated assembly system. Minimum rational work element, cycle time. Precedence constraints and diagram, Balance delay. Methods of Line balancing – Largest candidate rule, Kilbridge and Westers method, RPW method and numerical problems.

Text Books:

1. M.P.Groover & Emory W.Zimmer, **CAD/CAM, Computer Aided Design and Manufacturing**, Pearson India, 2007 2nd edition.
2. Mikell P.Groover, **Automation, Production system & Computer Integrated Manufacturing**, Pearson India, 2007 2nd edition.

Reference Books:

1. Ibrahim Zeid, **CAD/CAM theory and practice** Tata McGraw hill.

2. P. RadhaKrishnan, S. Subramanyan & V. Raju, **CAD/CAM/CIM** New Age international Publishers , 2nd edition.
3. P. RadhaKrishnan, **Computer Numerical Control Machines and CAM** New Age international Publishers, 1st edition 2012.
4. P. N. Rao **CAD/CAM Principles and applications**, Tata McGraw hill.

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
B18ME6270	**Heat Transfer Lab**	HC	0	0	2	2	3
Prerequisites: Basic & Applied Thermodynamics, Fluid mechanics		Internal Assessment			Semester End Exam		
		20 Marks			30 Marks		

Course Objectives:

1. To learn the various modes of heat transfer
2. To know performance of the fins.
3. To understand the heat transfer by convection.
4. To learn the performance of the heat exchangers.
5. To study the unsteady heat transfer

Course Outcomes:

By the end of the course the student shall be able to

1. Define conduction, convection and radiation heat transfer.
2. Determine the heat transfer coefficient under various conditions.
3. Conduct the experiment to find the effectiveness of the fin.
4. Find out the radiation heat transfer properties.
5. Prepare the document based on the conduction of the experiment.

List of Experiments:

1. Determination of Thermal Conductivity of Metal rod.
2. Determination Overall heat transfer co-efficient of composite wall.
3. Determination of Effectiveness and efficiency of a Metallic fin.
4. Determination of Heat Transfer Coefficient for a free Convection on vertical and horizontal tube.
5. Determination of Heat Transfer Coefficient for a Forced Convention Flow through a Pipe.
6. Emissivity of a Surface.
7. Determination of Stefan Boltzmann Constant.
8. Determination of LMDT and Effectiveness for a Parallel Flow and Counter Flow Heat
9. Exchangers.
10. Experiment on Transient Conduction Heat Transfer.
11. Demonstration on Boiling of Liquid and Condensation of Vapour.

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
B18ME6280	CIM and Automation Lab	HC	0	0	2	2	3
Prerequisites: CAD/CAM/CIM		Internal Assessment			Semester End Exam		
		20 Marks			30 Marks		

Course Objectives:

1. To train the students with part programming concepts
2. Generation of manual part programming – CNC Turn and CNC mill
3. Generation of tool path and NC part program by using part Geometry.

Course Outcomes:

By the end of the course, the student shall be able to

1. Generate the part program for the given profile/part geometry – offline
2. Able to work on CNC machines.

List of Experiments:

CNC, Part Programming using CAM packages simulation of Turning, Drilling and milling operations. Simulations to be carried out using simulation packages like Master CAM, Edge CAM, Cadem , MTAB or any equivalent software. (Model should consist of Minimum 4 operations).

DEMO of Flexible Manufacturing system, ASRS, AGVS Robot Programming, Hydraulic and pneumatic, basics of these topics to be conducted.

Reference: Manual prepared by REVA University Faculty.

Note: Students should write the manual part programming in the observation book by using machine language codes and after the simulation of the cutter tool path , the students should take the print out of that profile & program and at the end should submit the soft bind report.

SEVENTH SEMESTER

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
B18ME7010	**Finite Element Methods**	HC	2	1	0	3	4
Prerequisites: Mechanics of Materials/ Engg Mathematics		Internal Assessment			Semester End Exam		
		40 Marks			60 Marks		

Course Objectives:

1. To enable the students to understand the mathematical and physical principles underlying the Finite Element Method (FEM) as applied to solid mechanics and heat transfer problems.
2. To provide systematic and comprehensive knowledge of basics of Finite element method as an analysis tool.
3. To teach the students the characteristics of various elements and selection of suitable elements for the problems being solved.
4. To make the students derive finite element equations for simple and complex elements.
5. To make the student solve for field variable for thermal composite wall problems.

Course Outcomes:

By the end of the course the student shall be able to

1. Describe the different types of analysis methods and various approaches in Finite Element Method
2. Analyze the Interpolation polynomials by Euler-Lagrange equations and Solution to 1-D Bars
3. Determine the stiffness matrix and unknown DOFs of Trusses and derive shape functions for Higher Order Elements
4. Derive Hermite Shape function and apply it to solve beam problems.
5. Apply FEM method to solve 1D heat transfer problems and composite walls.

UNIT–1 Introduction [11 hrs]

Introduction: Background of Various Stress analysis methods, Principle of minimum PE, Variation approach-Rayleigh Ritz method, Weighted Residual methods, Galerkin method simple problems, Comparison of FEM with classical methods. Advantages and limitations of FEM, Steps involved in FEM, Applications of FEM and FEM Packages.

Discretization: Element shapes and behavior , Choice of element types , size and number of elements ,Element shape and distortion ,Location of nodes , Node and Element numbering.

UNIT–2 Interpolation Models and Solution of 1-D Bars [11 hrs]

Interpolation polynomials- Linear, quadratic and cubic. Simplex complex and multiplex elements.2D PASCAL's triangle. CST elements-Shape functions in NCS, Strain displacement matrix and Jacobian for triangular element.(no derivation)

Solution of 1-D Bars: Solutions of bars and stepped bars for displacements, reactions and stresses by using penalty approach and elimination approach.

UNIT–3 Trusses and Higher Order Elements [11 hrs]

Trusses: Stiffness matrix of Truss element. Numerical

Higher Order Elements: Lagrange's interpolation, Higher order one dimensional elements-Quadratic and cubic element and their shape functions. Shape function of 2-D quadrilateral elements. Iso

parametric, Sub parametric and Super parametric elements. Numerical integration: 1 and 2 gauss point for 1D case.

UNIT –4 Beams and Heat Transfer **[12 hrs]**

Beams: Hermite shape functions for beam element, Derivation of stiffness matrix.(no derivation of load vectors) Numerical problems of beams carrying concentrated, UDL and linearly varying loads.

Heat Transfer: Steady state heat transfer, 1D heat conduction governing equations, Galerkin's approach for heat conduction and solution for composite walls.

Text Books:

1. S.S. Bhavikatti, **Finite Element Analysis**, New Age International publishers,2006
2. T.R.Chandrapatla, A.D Belegunde, **Finite Elements in Engineering** 3rd Ed PHI.

Reference Books:

1. Daryl. L. Logon, **Finite Element Methods**, Thomson Learning 3rd edition, 2001.
2. J.N.Reddy, **Finite Element Method**, McGraw -Hill International Edition.
3. R.D. Cook D.S Maltus, M.E Plesha, R.J.Witt, **Concepts and applications of Finite Element Analysis,** Wiley 4th Ed, 2009

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
B18ME7020	**Control Engineering**	HC	3	0	1	4	5
Prerequisites: Mathematics		Internal Assessment			Semester End Exam		
		40 Marks			60 Marks		

Course Objectives:

1. To provide knowledge of fundamentals related to automatic control, feedback systems and their applications in real time.
2. Use of mathematical tool like Laplace transforms to analyze the system theoretically.
3. Representation of actual system in terms of physical model and mathematical model by writing mathematical equations.
4. To analyze the behavior of the system for various inputs under time domain and frequency domain.
5. To analyze the performance and stability by using plots like polar plot, bode plot and root locus techniques.

Course Outcomes:

By the end of the course the student shall be able to

1. Use practical aspects of automation.
2. Model the real time system into mathematical model to design cost effective sophisticated device.
3. Analyze and test mathematical model by using various techniques under time domain and frequency domain.
4. Use graphical techniques like Bode plot, Nyquist plot and root locus plot to check the stability of the model theoretically

Course Content:

UNIT -1: Mathematical Modeling and Block Diagrams [11 hrs]

Concepts of automatic controls, Types of control systems, open and closed loop systems with examples, feedback system. Requirement of an ideal control system. Mathematical Models: Models of mechanical systems, Transfer function, Numerical on mechanical system and transfer function, Block Diagrams: block representation of system elements, reduction of block diagrams

UNIT -2: Signal Flow Graphs and Time Response Analysis [11 hrs]

Mason's gain formula, numerical. Time Response Analysis: Transient and Steady State Response Analysis: types of inputs, first order and second order system response to step, ramp and impulse inputs, (no derivation), time response specifications and concepts of time constant, numerical problems, System stability: Routh's-Hurwitz Criterion, numerical.

UNIT–3: Frequency Response Analysis [11 hrs]

Polar plots, Nyquist Stability Criterion, Stability Analysis, phase and gain margin, Stability Analysis using Bode plots, Simplified Bode Diagrams.

UNIT- 4: Root Locus Plots and Compensation Techniques [12 hrs]

Definition of root loci, general rules for constructing root loci, Analysis using root locus plots. Types of controller & compensation techniques: proportional controller, differential controller, PI, PD & PID controllers, compensation, compensation techniques-series, parallel, lead, lag, lead & lag compensation.

Text Books:

1. K. Ogatta. **Modern Control Engineering** Pearson education, 2003
2. M.Gopal**, Control Systems principles & design** TMH, 2000

Reference Books:

1. I.J.Nagarath & M.Gopal **Control Systems** New age International Publishers
2. Schaum's series **Feedback Control Systems** 2001

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
B18ME7030	**Engineering Economics and Financial Management**	HC	4	0	0	4	4
Prerequisites: Basics of Management		Internal Assessment			Semester End Exam		
		40 Marks			60 Marks		

Course Objectives:

1. To Study principles and techniques of economic evaluation in different field of Engineering
2. To know the assessment procedure for the financial position of an organization.
3. To calculate interest under various conditions, know time value of the money.
4. To learn Budgeting process and its preparation and use

Course Outcomes:

By the end of the course the student shall be able to

1. Describe Economic strength of organization and , its functions
2. Calculate NPV, NPW, EAW and compare and select best project.
3. Calculate EMI, interest and IRR to understand time value of the money.
4. Prepare budget, financial ratio's to assess financial strengths and weakness etc.

Course Content:

UNIT–1 Introduction to Engineering Economy [11 hrs]

Introduction to Indian Economy, Basic terminologies used in economy, Engineering Decision-Makers, Engineering and Economics, Problem solving and Decision making, Intuition and Analysis, Tactics and Strategy. Law of demand and supply, Interest and Interest factors: Interest rate, Cash – flow diagrams, Exercises and Discussion.

Present-Worth Comparisons: Conditions for present worth comparisons, Basic Present worth Comparisons, Present-worth equivalence, Net Present worth, Assets with unequal lives, infinite Lives, Future-worth comparison, Pay-back comparison, Simple Exercises.

UNIT–2 Evaluation of Projects and Depreciation [11 hrs]

Present worth Method, Annual worth method, Future worth method, Internal rate of return method

Numerical covering all the above method with comparisons. Rate-of-Return Calculations, Minimum acceptable rate of Return, IRR, IRR misconceptions

Depreciation: Causes of Depreciation, Methods of depreciation. Simple Numerical, Tax- Direct and Indirect tax, GST and simple concepts of taxing.

UNIT–3 Estimation, Costing and Final Accounts [11 hrs]

Estimation for simple components (with calculations of all types of costs involved in it).

Introduction, Scope of Finance, and Finance Functions, Statements of Financial Information: Source of financial information, financial statements, Balance sheet, Profit and Loss Account, relation between Balance sheet and Profit and Loss account. Simple Numerical .

UNIT–4 Financial Ratio Analysis and Profit Planning [12 hrs]

Financial Ratio Analysis: Introduction, Nature of ratio analysis, Liquidity ratios, Leverage ratios, Activity ratios, Profitability ratios, Evaluation of a firm's earning power. Simple numerical

Financial and Profit Planning: Introduction, Financial planning, Profit planning, Objectives of Profit planning, type of budgets in Indian Economy, preparation of Budgets, advantages, problems on flexible budget, cash budget and production budget.

Text Books:

1. Riggs J.L., **Engineering Economy**, 4TH ed. , McGraw Hill, 2002
2. Thuesen H.G. **Engineering Economy** PHI , 2002
3. Ramesh Singh, **Indian Economy**, 8th edition,2018
4. Khan & Jain, **Financial Management**,Text and Problems, 5th Edition, TMH, ISBN 0-07-460208 A, 2001.

Reference Books:

1. Tarachand, **Engineering Economy,** 2000.
2. O P Khanna, **Industrial Engineering and Management**, Dhanpat Rai & Sons. 2000
3. Prasanna Chandra, **Financial Management,** 7th Ed., TMH, 2004
4. IM Pandey **Financial Management,** , Vikas Pub. House, 2002

Soft Core-7

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
B18ME7041	**Cryogenic Engineering**	SC	3	0	0	3	3
Prerequisites: Engineering Thermodynamics , Applied Thermodynamics		Internal Assessment			Semester End Exam		
		40 Marks			60 Marks		

Course Objectives:

1. To give exposure to the basic principles of low temperature and its application
2. To enable the students to understand various methods of obtaining cryogenic temperature.
3. To teach students about properties of metals at low temperature.
4. To expose the students to various methods of gas liquefaction.
5. To teach students about the working of various low temperature refrigerators and cooling devices.
6. To enhance the knowledge in measurement of various parameters under low temperature.

Course Outcomes:

By the end of the course, the student shall be able to

1. Differentiate cryogenics and refrigeration and also application
2. Identify the suitable methods for liquefaction of gases
3. Explain variety of refrigerator and devices used to get low temperature
4. Apply suitable measurement techniques in low temperature measurement
5. Acquire knowledge of cryogenics and importance in various fields.

Course content:

UNIT-1 Introduction to Low Temperature Engineering [11 hrs]

Cryogenics, Principles of cryogenics , Methods of production of low temperature ,Cryogenic fluids, Superconductivity and its applications ,Super fluidity, Low temperature properties of structural materials ,Applications of Cryogenics.

UNIT-2 Gas Liquefaction and Cryogenic Systems [11 hrs]

Liquefaction of gases – Linde Hampson system , Claude system ,Heylandt system – Critical components of liquefiers, Cryo coolers – Stirling Cryocooler , Gifford , McMahon cryo cooler –,Pulse tube cryo cooler.

UNIT-3 Gas Separation and Purification Systems [11 hrs]

Properties of mixtures – Principles of gas separation, Air, Hydrogen and Helium separation systems– Gas purification methods. Ultra low temperature refrigerators, magneto caloric refrigerator, 3He-4Hedilution refrigerator, Pomeranchuk cooling.

UNIT-4 Storage and Transfer Systems, Cryogenic Instrumentation [12 hrs]

Cryovessels – Concept of vapour coated shields , Cryogenic insulation – Vacuum, powder, multilayer insulation, Micro-sphere insulation. Cryogenic fluid transfer- transfer lines, pressurization, Transfer pump.

Cryogenic Instrumentation: Temperature, pressure, flow and level, measurement at low temperature – Cryostats – Cold electronics.

Text Books:

1. Randall F. Barron, **Cryogenic Systems**, (1999), Oxford University Press, New York.
2. Thomas M Flynn, **Cryogenic Systems**, Marcel Dekker, Inc N.Y. Basal 1997

Reference:

1. Haselden, G.G. **Cryogenic Fundamentals,** (1999), Academic Press Inc., London

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
B18ME7042	**Tribology and Bearing Design**	SC	3	0	0	3	3
Prerequisites: Material Science, Transmissions of machine elements		Internal Assessment			Semester End Exam		
		40 Marks			60 Marks		

Course Objectives:

1. To understand the principles of lubrication& regimes of lubrication.
2. To understand the genesis of friction, laws of sliding and rolling friction
3. To learn about consequences of wear, wear mechanisms, wear theories.
4. Knowledge of theories of hydrodynamic, Elasto-hydrodynamic and mixed/ boundary lubrication.
5. To learn about tribological testing and experimental techniques in tribology in order to learn about the tribology of different machine elements.

Course Outcomes:

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

1. Apply the knowledge of theory of friction to solve engineering problems
2. Derive the equation for Idealized Journal Bearing and Slider / Pad Bearing with A Fixed and Pivoted Shoe
3. Derive the Oil Flow and Thermal Equilibrium equations of Journal Bearing and Hydrostatic Lubrication.
4. Identify the properties of Bearing Materials and analyze the Behavior of Tribological Components.

Course Content:

UNIT–1 Introduction to Tribology and Hydrodynamic Lubrication [11 hrs]

Introduction to Tribology: Properties of oils and equation of flow: Viscosity, Newton's Law of viscosity, Hagen-Poiseuille Law, Flow between parallel stationary planes, viscosity measuring apparatus regimes of lubrication classification of lubricants.

Hydrodynamic Lubrication: Friction forces and power loss in lightly loaded bearing, Petroff's law, Tower's experiments, mechanism of pressure development in an oil film, Reynold's investigation and Reynold's equation in 2D.

UNIT–2 Performance of Bearings [11 hrs] Idealized

Journal Bearing: Introduction to idealized journal bearing, load carrying capacity, condition for equilibrium,Sommerfeld's numbers and significance of it; Partial bearings, end leakages in journal bearing, numerical.

Slider / Pad Bearing with A Fixed and Pivoted Shoe: Pressure distribution, Load carrying capacity, coefficient of friction, frictional resistance in a pivoted shoe bearing, numerical.

UNIT–3 Thermal Equilibrium of Journal Bearing [11 hrs]

Oil Flow and Thermal Equilibrium of Journal Bearing: Oil flow through bearings, self-contained journal bearings, bearings lubricated under pressure, thermal equilibrium of journal bearings.

Hydrostatic Lubrication: Introduction to hydrostatic lubrication, hydrostatic step bearings, load carrying capacity and oil flow through the hydrostatic step bearing.

UNIT - 4 Bearing Materials and Tribological Components [12 hrs]

Bearing Materials: Commonly used bearings materials, properties of typical bearing materials. Advantages and disadvantages of bearing materials.

Behavior of Tribological Components: Selection, friction, Wear of ceramic materials, wear measurements, effects of speed, temperature and pressure. Tribological measures, Material selection, improved design, surface engineering.

Text Books:

1. B.C. Majumdar, **Introduction to Tribology Bearings**, Wheelers and company pvt. Ltd., 2011-12. ISBN:81-219-29870
2. Basu S K., Sengupta A N., Ahuja B. B., **Fundamentals of Tribology** , PHI 2006

Reference Books:

1. Fuller, D., **Theory and Practice of Lubrication for Engineers,** New York company 1998
2. Moore,**Principles and Applications of Tribology,** Pergamaon press 1998
3. Srivastava S., **Tribology in Industries,** S Chand and Company limited, Delhi 2002
4. Redzimovskay E I., **Lubrication of bearings – Theoretical Principles and Design,** Oxford press company 2000.

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
B18ME7043	**Automation in Manufacturing**	SC	3	0	0	3	3
Prerequisites: CAD/CAM/CIM		Internal Assessment			Semester End Exam		
		40 Marks			60 Marks		

Course Objectives:

1. Explore the concept of automation and building blocks, Fundamentals of manufacturing.
2. Identify the manufacturing support systems to different industries.
3. Enumerate the knowledge of automated production, group technology and cellular manufacturing concept.
4. Exposure to gain knowledge about automated inspection technologies.

Course Outcomes:

By the end of the course student shall be able to

1. Evaluate the product and production relationships.
2. Evaluate the utilization and availability of the infrastructure in the automated production line (APL).
3. Study the new automation technologies like Group Technology (GT), Bar code systems, Lean manufacturing, JIT, Agile manufacturing.
4. Implement the concept of inspection technology for modern automated industry requirements.

Course Content:

UNIT –1 Introduction and Industrial Control System [11 hrs]

Introduction: Production System Facilities, Automation definition, type and reason, Manuel labour in production system, product and production relationship, cost of manufacturing operation.

Industrial Control System: Basic Elements of an Automated System, Advanced Automation Functions & Levels of Automation, Continuous versus Discrete control, Computer Process control, Forms of Computer Process Control.

UNIT– 2 Manufacturing Support System [11 hrs]

Process Planning, Computer Aided Process Planning, and Concurrent Engineering & Design for Manufacturing, Advanced Manufacturing Planning, Just-in Time Production System, Basic concepts of lean and Agile manufacturing.

UNIT –3 Group Technology and Flexible Manufacturing Systems [11 hrs]

Part Families, Parts Classification and coding, Production Flow Analysis, Cellular Manufacturing, Flexible Manufacturing Systems (FMS) and its components, FMS Applications & Benefits, FMS Planning & Implementation Issues.

UNIT–4 Inspection Technologies [12 hrs]

Inspection Technologies: Automated Inspection, Coordinate Measuring Machines Construction, operation & Programming, Software, Application & Benefits, Flexible Inspection System, Inspection Probes on Machine Tools, Machine Vision, Optical Inspection Techniques & Non-contact Non-optical Inspection Technologies.

Quality Control Systems: Traditional and Modern Quality Control Methods, Taguchi Methods in Quality Engineering. Introduction to SQC Tools

Text Books:

1. M. P. Groover, **Automation, Production Systems and Computer Integrated Manufacturing,** Pearson education. Third Edition, 2008
2. Vajpayee **Principles of CIM,** , PHI.

Reference Books:

1. Amber G.H & P. S. Amber, **Anatomy of Automation**, Prentice Hall.
2. Viswanandham, **Performance Modeling of Automated Manufacturing Systems,** PHI.
3. Krishna Kant, **Computer Based Industrial Control**, EEE-PHI.

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
B18ME7044	**Non Destructive Testing**	SC	3	0	0	3	3
Prerequisites: Manufacturing Technology		Internal Assessment			Semester End Exam		
		40 Marks			60 Marks		

Course Objectives:

1. To acquire the principle behind various NDT techniques and study about NDT equipments and accessories
2. To study the considerations for selection of appropriate NDT technique(s) for various applications
3. To enumerate the working procedures of various NDT techniques
4. To study the common types of defects arising in different types of manufactured products to evaluate them.

Course Outcomes:

By the end of the course student shall be able to

1. State the principles used in different types of NDT techniques
2. Compare the advantages of various NDT techniques for various applications.
3. Select the different types of NDT equipments for real time applications
4. Identify the causes for the different types of defects that may result in castings and suitable measures to eliminate them.

Course Content:

UNIT-1 Visual Inspection and Liquid Penetrate Testing [11 hrs]

Introduction, Visual inspection and Liquid particle testing: Introduction to various non destructive methods- Comparison of Destructive and Non destructive Tests, Visual Inspection, Optical aids used for visual inspection, Applications. Basic principle, procedure for penetrant testing, Penetrant Testing materials, Penetrant testing methods-water washable, post-Emulsifiable methods, Applications.

UNIT-2 Magnetic Particle Testing and Eddy Current Testing [11 hrs]

Magnetic Particle Testing and Eddy current testing: Principle of MPT, procedure used for testing a component, Equipment used for MPT, Applications. Principles, Instrumentation for ECT, Absolute-differential probes, Techniques-High sensitivity Techniques, Applications

UNIT-3 Acoustic Emission Testing and Ultrasonic Testing [11 hrs]

Acoustic Emission Testing:Principle of AET, Instrumentation, Applications – testing of metal pressure vessels, Fatigue crack detection in aerospace structures.Ultrasonic Testing:Principle of Ultrasonic testing, Ultrasonic transducers ,Inspection Methods, Normal Incident Pulse – Echo Inspection, Through – transmission Testing, angle Beam Pulse- Echo testing, Techniques for Normal Beam Inspection, Ultrasonic Flaw detection Equipment, Modes of display A- scan, B-Scan, C-Scan, Applications.

UNIT-4 Radiography Testing [12 hrs]

Radiography, Comparison and selection of NDT methods: Basic principle, Effect of radiation on Film, Radiographic imaging, Inspection Techniques-Single wall single image, Double wall Penetration, Multiwall Penetration technique. Comparison and selection of various NDT techniques.

Text Books:

1. Baldev raj T, Jayakumar M. Thavasimuthu "**Practical Non Destructive Testing**", 3rd edition, Narosa publishing house, New Delhi

   2.American Society for Metals, "**Non-Destructive Evaluation and Quality Control**": MetalsHand Book: 1992, Vol. 17, 9th Ed, Metals Park, OH.

Reference Books:

1. Krautkramer. J., **Ultra Sonic Testing of Materials**, 1st Edition, Springer Verlag Publication, New York, 1996.
2. Peter J. Shull Non Destructive Evaluation: **Theory, Techniques and Application** Marcel Dekker, Inc., New York, 2002

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
B18ME7045	**Safety Engineering**	SC	3	0	0	3	3
Prerequisites: None		Internal Assessment			Semester End Exam		
		40 Marks			60 Marks		

Course Objectives:

1. To know the reasons for accidents happen in mechanical Industries
2. To understand the safety procedure to avoid accidents
3. To know the safety rules and regulations.
4. To understand the various acts of Govt of India.
5. To know the responsibility as a citizen, employer, employee and head of the family

Course Outcomes:

By the end of the course student shall be able to

1. Define various reasons for industrial accidents.
2. Explain various safety methods used for mechanical handling.
3. Explain the precautions to be taken to handle chemicals and gases.
4. Describe the rules and regulations made by Govt of India for health, safety and environment.

Course Content:

UNIT-1 Accidents and Safety [11 hrs]

Definitions and theories.- Accident - Injury - Unsafe act - Unsafe condition -Dangerous occurrence - Theories and principles of accident causation - Cost of accidents - Accident reporting and investigations - Safety committees - Need - Types- Advantages. Safety education and training - Importance - Various training methods -Accident prevention - Motivating factors - Safety suggestion schemes. Safety performance - Definitions connected with measuring safety performance as per Indian and International standards.

UNIT- 2 Safety in Mechanical Handling [11 hrs]

General safety consideration in material handling - Ropes, Chains, Sling, Hoops, Clamps, arresting gears - Prime movers. Ergonomic consideration in material handling, design, installation, operation and maintenance of conveying equipments, hoisting, traveling and slewing mechanisms. Selection, operation and maintenance of industrial trucks - Mobile cranes - Tower crane.

UNIT-3 Safety in Storage and Handling of Chemicals and Gases [11 hrs]

Safety in the design process of chemical plants - Safety in operational and maintenance - Exposure of personnel - Operational activities and hazards - Safety in storage and handling of chemicals and gases - Hazards during transportation - Pipeline transport - Safety in chemical laboratories. Specific safety consideration for cement, paper, pharmaceutical, petroleum, petro - chemical, rubber, fertilizer and distilleries.

UNIT-4 Regulations for Health, Safety and Environment [12 hrs]

Factories act and rules; - Indian explosive act - Gas cylinder rules – Environmental pollution act - Indian petroleum act and rules - Oil industry safety directorate (OISD) - Indian Electricity act and rules. - Mines act and rules - Indian motor vehicles act and rules.

Text Books:

1. Handlin.W**, "Industrial Hand Book",** McGraw-Hill, 2000.
2. Anton.T.J, **"Occupational safety and health management",** (2nd Edition). New York, McGraw Hill, 1989.

Reference Books:

1. Heinrich.H.W, **"Industrial Accident Prevention***"*, McGraw-Hill, 1980.
2. Rudenko.N, **"Material Handling Equipments",** Mir Publishers, Moscow, 1981.
3. Lees.F.P, **"Loss "Prevention in Process Industries",** Butterworths, NewDelhi,1986.
4 **IS CODES of Oil Industry Safety Directorate**, Govt. of India.

Soft Core-8

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
B18ME7051	**Computational Fluid Dynamics**	SC	2	1	0	3	4
Prerequisites: Fluid Mechanics, Heat Transfer, Engineering Thermodynamics		Internal Assessment			Semester End Exam		
		40 Marks			60 Marks		

Course Objectives:

1. To get basic knowledge of fluid mechanics and its mathematical description.
2. An ability to apply knowledge of mathematics and science to engineering by describing a continuous fluid-flow phenomena in a discrete numerical sense.
3. To provide the students with sufficient background to understand the mathematical representation of the governing equations of fluid flow and heat transfer
4. An ability to use the techniques, skills, & engineering tools necessary for engineering practice by applying numerical methods to a "real-world" fluid-flow problem, integrating various numerical techniques in formulating a numerical solution method
5. To enable the students to solve one and two-dimensional ordinary and partial differential equations using traditional CFD tools.

Course Outcome:

By the end of the course the students shall be able to

1. Define ,formulate and analyze Fluid mechanics
2. Identify different mathematical equations

3. Solve fluid flow fields using CFD methods.
4. Possess the knowledge of CFD techniques, basic aspects of discretization and grid generation.
5. Model fluid flow problems and heat transfer.
6. Solve Real world problem.

Course Content:

UNIT -1 Introduction and Basic Governing Equations [11 hrs]

Introduction, advantages, applications of CFD in different fields, the future of computational fluid dynamics -Governing equations of fluid dynamics-Continuity, Momentum and energy in differential form& vector form, Boundary conditions ,Numerical errors -.truncation error, round off error.

UNIT -2 CFD Technique [11 hrs]

Basic aspects of discretization , Discretization techniques-Finite Element Method, Finite difference method and Finite volume method, Comparison of discretization by the three methods - Introduction to Finite differences three-dimensional continuity equation in Cartesian coordinates – Explicit - Implicit - Crank-Nicolson, Stability criterion. Navier- stokes equations in differential form.

UNIT -3 Simulation Techniques [11 hrs]

Important features of turbulent flow, Reynolds average Navier stokes (RANS) equation, Necessity of turbulence modeling, Different types of turbulence model: discussion on - Turbulent kinetic energy and dissipation, one equation- Spalart-Allmaras,two equationmodel: κ-ε model, Advantages and disadvantages ,RNG κ-ε model and κ-ω model.

UNIT -4 Application of CFD Tool [12 hrs]

Geometry creation, meshing, grid independent test, mesh refinement analysis, practical boundary condition validation, results. Convergence, accuracy.

Case study on pipe flow –Venturimeter, orifice meter& Nozzle meter

External flow-Flow over aero foil, flow over a cylinder by using CFD software.

Text Books:

1. J.D. Anderson, Jr., (2000), **Computational Fluid Dynamics – The basics with applications**, McGraw-Hill, Incs.
2. Jiyuan Tu **Computational fluid Dynamics – A practical approach**-Elsevier publication

Reference Books:

1. K. Muralidhar, T. Sundarajan, (2001), **Computational Fluid Flow and Heat Transfer**, Narosa Publishing House, New Delhi.
2. S.V. Patankar, (1999), **Numerical Heat Transfer and Fluid Flow**,Taylor & Francis
3. H K Versteeg & W Malasekera **An Introduction to Computational Fluid Mechanics**

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
B18ME7052	**Mechanical Vibrations**	SC	2	1	0	3	4
Prerequisites: Mathematics, KOM/DOM		Internal Assessment			Semester End Exam		
		40 Marks			60 Marks		

Course Objectives:

1. To know the fundamentals of vibration.
2. To study the un-damped and damped free vibration.
3. To analyze the forced vibrations.
4. To study the multi degrees of freedom system.
5. To teach the knowledge of vibration measuring instruments.

Course Outcomes:

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

1. Develop the differential equation for vibration model.
2. Analyze the systems with Damped free vibrations and Forced Vibrations for 1DOF.
3. Describe different vibration measuring instruments and determine Whirling speed of shafts.
4. Compute the natural frequencies of multi DOF systems using Numerical Methods and describe various Condition Monitoring methods.

Course Content:

UNIT–1 Introduction and Undamped Free Vibrations [11 hrs]

Introduction: Types of vibrations, Definitions, Simple Harmonic Motion (S.H.M.) and Principle of super position applied to SHM, Beats, Fourier theorem and simple problems.

Undamped Free Vibrations: Derivations for spring mass systems, Methods of Analysis, Natural frequencies of simple systems, Springs in series and parallel, Torsional and transverse vibrations, Effect of mass of spring and Problems. (Only Single Degree of Freedom)

UNIT–2 Damped Free Vibrations and Forced Vibrations [12 hrs]

Damped free vibrations: Types of damping, Analysis with viscous damping - Derivations for over, critical and under damped systems, Logarithmic decrement and Problems.

Forced Vibrations: Introduction, Analysis of forced vibration with constant harmonic excitation - magnification factor, rotating and reciprocating unbalances, excitation of support (relative and absolute amplitudes), and force and motion transmissibility, Problems. (Only Single Degree of Freedom)

UNIT–3 Two degrees of Freedom System and Measuring Instruments [10 hrs]

Systems with two degrees of Freedom: Principle modes of vibrations, Normal mode and natural frequencies of systems (without damping) – Simple spring mass systems, torsional systems, absolute and relative motions Undamped dynamic vibration absorber and Problems.

Vibration Measuring Instruments and Whirling of shafts: Instruments – Vibrometer, Accelerometer, Frequency measuring instruments and Problems. Whirling of shafts with and without damping, discussion of speeds above and below critical speeds and Problems.

UNIT– 4 Multi Degree Freedom of Systems and Condition Monitoring [12 hrs]

Numerical Methods for multi degree freedom of systems: Introduction, Maxwell's reciprocal theorem-Statement, Influence coefficients, Dunkerley's method, Stodola method, Holzer's method, Orthogonality of principal modes and Problems.

Modal analysis and Condition Monitoring: Machine maintenance techniques, condition monitoring and diagnosis, Signal analysis, dynamic testing of machines and structures, Experimental modal analysis.

Text Books:

1. S. S. Rao, **Mechanical Vibrations,** Pearson Education Inc, 4th edition, 2003.
2. V. P. Singh, **Mechanical Vibrations,** Dhanpat Rai & Company, 3rd edition, 2006.

Reference Books:

1. G. K.Grover,**Mechanical Vibrations,** Nem Chand and Bros, 6th edition, 1996.
2. W. T. Thomson, M. D. Dahleh and C. Padmanabhan,**Theory of Vibration with Applications,** Pearson Education Inc, 5th edition, 2008.
3. S. Graham Kelly, Schaum's outline Series, **Mechanical Vibrations:** Tata McGraw Hill, Special Indian Edition, 2007.
4. J. S. Rao & K. Gupta, **Theory and Practice of Mechanical Vibrations:** New Age International Publications, New Delhi, 2001.

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
B18ME7053	**Operation Research**	SC	2	1	0	3	4
Prerequisites: Basics of Mathematics and Probability		Internal Assessment			Semester End Exam		
		40 Marks			60 Marks		

Course Objectives:

1. To learn Fundamentals of OR, Formulation of an LPP. And determine the optimal solution for a LPP Problem
2. To learn applications of LPP such as transportation problem , Assignment problem , travelling salesman problem
3. To analyze the waiting line model for real world applications.
4. To determine the project completion time by using PERT and CPM.
5. To know the scheduling of machines in the shop floor by using Johnson's algorithm.
6. To know the conflict between the two players in a game and determine the best strategy for the play.

Course Outcomes:

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

1. Formulate LPP and determine its optimal solution
2. Solve transportation problem to determine optimal route and assignment
3. Draw network diagrams and determine CPM, Floats and PERT
4. Determine optimal sequencing and best strategy of the play
5. Ascertain the optimization techniques to real-life problems.

Course Content:

UNIT -1 Introduction to OR and Solution of LPP [11 hrs]

Introduction to Operation Research: Definition, Scope of OR, OR Models, Characteristics and phases of OR. Advantages and limitation of OR. Mathematical formulation of LPP, Assumptions in LPP. Graphical solutions of LPP, Convex and non convex sets.

Linear Programming Problem: Slack, surplus and Artificial variables, Simplex method & BIG-M, , Concept of duality, Special cases such as unbounded solution, multiple optimal solution, infeasible solution & degeneracy.

UNIT–2 Transportation Model and Application [11 hrs]

Formulation of transportation model, Determination of IBFS using different methods & optimality by modi (V-V) method. Balanced and unbalanced transportation Problem, Degeneracy in transportation problems and resolving degeneracy, maximization of transportation problem. Application of Transportation Problem: Assignment model – Hungarian Method, Formulation of the assignment model (Minimization and Maximization), Balanced and unbalanced model, Travelling salesman problem.

UNIT -3 Network analysis and Waiting Line Model [11 hrs]

Network analysis – PERT & CPM Techniques. Project scheduling, Basic terminology used in project network, network construction, time estimates, determination of critical path and its durations, Floats , Variance under probabilistic models, prediction of project completion date.

Waiting Line model : Queue system and characteristics of queuing models, Kendall's notation, classification of the queue. The M/m/1 :∞/FCFS queuing system, Numerical.

UNIT -4 Game Theory and Sequencing [12 hrs]

Game theory: Introduction, Definition, strategy, Formulation of games, pay off matrix, Maximin and minimax criteria, Saddle point, Types of games. Solution of game with and without saddle point, Graphical solution of 2 X n game & M X 2 game. Dominance property for rectangular game i.e., M x N game.

Sequencing : Johnson's algorithm, Assumptions in sequencing, n jobs to 2 machines, n jobs on 3 machines, n jobs on m machines, 2 jobs on n machines, graphical solution priority rules, processing of n jobs through m machines.

Text Books:

1. Prem kumar gupta and D.S.Hira, **Operations Research**, S.Chand Publication, New Delhi.
2. S.D.Sharma **Operations Research**, , Kedarnath ramanth & co.,

Reference Books:

1. Hiller and Liberman, **Introduction to Operation Research**, Tata McGraw hill.
2. Taha.H.A, **Operation Research and Introduction**, Pearson education edition.
3. Ravindran,**Operation Research: principles and practice**: Phillips and Solberg, wiley india ltd, 2nd edition 2007.
4. Kalavathy **Operation Research**, Vikas publications.

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
B18ME7054	**Gas Turbines and Jet Propulsion**	SC	2	1	0	3	4
Prerequisites: Engineering Thermodynamics Applied Thermodynamics		Internal Assessment			Semester End Exam		
		40 Marks			60 Marks		

Course Objectives:

1. To describe the working principle, operations and analysis of nozzles, diffusers and gas turbines.
2. To generalize the students to understand the concept of Combustion chambers/burners used in gas turbines.
3. To illustrate the design parameters involved in gas turbines and performance parameters.
4. To learn the principles of rocket and jet propulsions.
5. To summarize the principles of Rocket propulsions.

Course Outcomes:

By the end of the course student shall be able to

1. Possess the knowledge of working principle, operations and analysis of nozzles, diffusers and gas turbine cycles.
2. Explain the concept of Combustion chambers/burners used in gas turbines.
3. Possess the knowledge of design parameter involved in gas turbine analysis.
4. Students will get a good understanding about rocket and jet propulsion.
5. Acquire the knowledge of importance gas turbine in power plant.

Course Content:

UNIT-1 Gas Turbines [11 hrs]

Introduction, types of nozzles, types of Diffusers, Equation of Continuity Sonic Velocity and Mach Numbers, The Steady Flow Energy Equation in Gas Nozzles. open and closed cycle, gas turbine fuels, actual Brayton cycle, optimum pressure ratio for maximum thermal efficiency, work ratio, air rate, effect of operating variables on the thermal efficiency and work ratio, and air rate, simple open cycle turbine with regeneration, reheating and Intercooling, Combined steam and gas turbine plant.

UNIT-2 Gas Turbine Combustion Chamber/Burner [11hrs]

Introduction and types of burners – Can burner, Annular burner, Cannular burner, Relative advantages and disadvantages of different types of burners, zones of combustion chamber, requirements of combustion chamber, design criteria of combustion chamber, pressure losses, combustion intensity and combustion efficiency, flame stabilization and flame holder Critical Design parameters of combustion chamber Materials for combustion chamber.

UNIT-3 Axial and Radial Flow Gas Turbines and Prediction of Performance [11 hrs]

Elementary theory of axial flow turbine, vortex theory, choice of blade profile, pitch and chord, estimation of blade performance, overall turbine performance, the tooled turbine, the radial flow turbine. Component characteristics, off-design operation of the single-shaft gas turbine, equilibrium running of a gas generator, off-design operation of free turbine engine.

UNIT-4 Jet and Rocket Propulsion [12 hrs]

Turbo jet engine The ram jet engine, pulse jet engine, turbo prop engine, , thrust equation, specific thrust, principles of rocket propulsion, ideal chemical rocket, advantages of liquid over solid propellants, free radical propulsion, nuclear propulsion, electro dynamics propulsion, photon propulsion, Numerical

Text Books:

1. R. Yadav, **Steam and Gas Turbines** - Central Publishing House, Allahabad

Reference Books:

1. H.I.H. Saravanamuttoo, G.F.C. Rogers & H Cohen, **Gas Turbine Theory** - Pearson Education.
2. V. Ganesan, **Gas Turbines** - Tata McGraw-Hill Publications.

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
B18ME7055	**Data Analytics using R-Programming**	SC	2	0	1	3	4
Prerequisites:		Internal Assessment			Semester End Exam		
		40 Marks			60 Marks		

Course Objectives:

1. To understand the basics of Big Data
2. To know the role and use of Big Data in various relevant industries
3. To have a clear idea on the various tools and techniques used with big data
4. To get the overview of various types of Big Data Analytics
5. To understand the basics in R programming in terms of constructs, control statements, string functions
6. To provide basic knowledge of data visualization techniques
7. To study on various linear and Non-linear models used in data analysis
6. Able to appreciate and apply the R programming from a statistical perspective.

Course Outcomes:

By the end of the course student shall be able to

1. Describe the big data in business context
2. Differentiate between various analytical approaches
3. Describe the basics of R
4. Describe the basic statics of the language.

Course Content:

UNIT -1: Overview of Big Data and Big Data in Business Context [11 hrs]

Overview of Big Data: Big Data - History of Data Management – Evolution of Big Data - Structuring Big Data - Types of Data - Elements of Big Data – Volume – Velocity – Variety – Veracity - Big Data Analytics - Advantages of Big Data Analytics - Careers in Big Data. **Use of Big Data in Business Context**: Use of Big Data in Social Networking - Business Intelligence – Marketing - Product Design and Development - Use of Big Data in Preventing Fraudulent Activities - Use of Big Data in Detecting Fraudulent Activities

in Insurance Sector - Fraud Detection Methods - Use of Big Data in Retail Industry - Use of RFID Data in Retail.

UNIT -2: Analytics and Big Data Tools [11hrs]

Analytical Approaches and Tools to Analyze Data: Analytical Approaches - Ensemble Methods - Graphical User Interfaces - Point Solutions - Data Visualization Tools - Introducing Popular Analytical Tools - The R Project for Statistical Computing - IBM SPSS – SAS - Comparing Various Analytical Tools. **Understanding Hadoop Ecosystem :**Hadoop Ecosystem - Hadoop Distributed File System – MapReduce - Hadoop YARN - Introducing HBase - Combining HBase and HDFS – Hive -Pig and Pig Latin –Sqoop –ZooKeeper –Flume –Oozie

UNIT -3 Basics of R [11 hrs]

Basic Statistics: Summary Statistics - Correlation and Covariance - T-Tests - ANOVA. Linear Models: Simple Linear Regression - Multiple Regression. Generalized Linear Models: Logistic Regression - Poisson Regression - Other Generalized Linear Models - Survival Analysis. Nonlinear Models: Nonlinear Least Squares - Splines - Generalized Additive Models - Decision Trees - Random Forests.Building R Packages: Folder Structure - Package Files - Package Documentation - Checking, Building and Installing - Submitting to CRAN - C++ Code.

UNIT -4: Basic Statistics [12 hrs]

Basic Statistics: Summary Statistics - Correlation and Covariance - T-Tests - ANOVA. Linear Models: Simple Linear Regression - Multiple Regression. Generalized Linear Models: Logistic Regression - Poisson Regression - Other Generalized Linear Models - Survival Analysis. Nonlinear Models: Nonlinear Least Squares - Splines - Generalized Additive Models - Decision Trees - Random Forests.Building R Packages: Folder Structure - Package Files - Package Documentation - Checking, Building and Installing - Submitting to CRAN - C++ Code.

Text Books:

1. **Big Data (Hadoop 2, MapReduce, Hive, YARN, Pig, R and Data Visualization) Black Book**, published by Dreamtech Press, 2016. (Units 1 and 2)
2. Jared P. Lander, **"R for Everyone (Advanced Analyticsand Graphics)",** published by Addison-Wesley, 2013. (Unit 3,4).

Reference Books:

1. Paul Buhler, WajidKhattak and Thomas Erl, "**Big Data Fundamentals: Concepts, Drivers & Techniques**", Prentice Hall Publications, 2016.
2. Norman Matloff, "**The Art of R Programming**", published by William Pollock, 2011.

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
B18ME7070	**Structural Analysis Lab**	HC	0	0	2	2	3
Prerequisites: FEM, SOM		Internal Assessment			Semester End Exam		
		20 Marks			30 Marks		

Course Objectives:

1. To provide sound knowledge of stress, displacement, deformation and load distribution of the beam.
2. To familiarize with the stress concentration factor.
3. To provide capability to analyze and solve practical problems based on the concept of principle of super position.
4. To analyze trusses problems & its application in the real world scenario.
5. Carryout dynamic analysis of Fixed – fixed beam for natural frequency and complex problems.
6. To carryout thermal analysis in order to determine the heat flux and temperature distribution of the domain.

Course Outcomes:

By the end of the course the student shall be able to

1. Apply the numerical methods for various applications of Mechanical Engineering
2. Analyze effect of stress concentration factor.
3. Analyze and solve practical problems of concept of stepped & tapered bar.
4. Analyze truss problems and provide solutions for the dynamic problems associated with various conditions
5. Determine natural frequency of fixed - fixed beam.

List of Experiments:

PART – A

Study of a FEA package and modeling, stress analysis of

1. Bars of constant cross section area, tapered cross section area and stepped bar (Minimum 6 Exercises)
2. Trusses –(Minimum 2 exercises).
3. Beams – Simply supported, cantilever, beams with UDL, beams with varying load etc (Minimum 6 exercises).

PART – B

1. Stress analysis of a rectangular plate with a circular hole
2. Thermal Analysis – 1D & 2D problem with conduction and convection boundary Conditions (Minimum 4 exercises)
3. Dynamic Analysis
   a. Fixed – fixed beam for natural frequency determination
   b. Bar subjected to forcing function
   c. Fixed – fixed beam subjected to forcing function

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
B18ME7080	Product Design and Concept Lab	HC	0	0	2	2	3

Prerequisites: None	Submission of Report	Presentation
	20 Marks	30 Marks

Course Objectives:

1. To extract his /her idea of his own.
2. To make a model by using modern tools.
3. To develop a skill tom convert idea into product.
4. To develop writing, presentation and documentation skill.

Course Outcomes:

By the end of the course the student shall be able to

1. Apply the knowledge of Mechanical Engineering.
2. Explain his idea or concept. Technically.
3. Develop small components or model.
4. Illustrate his idea in terms of presentation and documentation

It is project based learning student/s have to take their ideas or concept and make computer modeling. Analysis of that model has to done by use of analysis software and makes the prototype model of the component by using Rapid prototyping machine. At the end student has to submit the report and give the presentation to the committee. Based on the report and presentation final marks will be awarded for maximum of 50.

OPEN ELECTIVE

(FOR STUDENTS OF OTHER SCHOOLS)

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
B18ME7061	**Project Management**	OE	4	0	0	4	4
Prerequisites: Management		Internal Assessment			Semester End Exam		
		40 Marks			60 Marks		

Course Objectives:

1. To provide the knowledge of project management, methodology
2. To know the use of project management tools, techniques and skills.
3. To give knowledge to manage the project cost, quality and delivery.
4. To learn the skill of selection and initiation of individual projects and portfolios of projects in the enterprise.

.**Course Outcomes:**

By the end of the course the student shall be able to

1. Identify specific management needs in the execution of projects at tactical and strategic level.
2. Estimate the project proposals for scope, time and cost to consider its feasibility.
3. Synthesis the strategies to evolve suitable approach to accomplish the project with effective usage of the resources.
4. Illustrate the team building and leadership skills in planning and implementation of the project.
5. Apply effective management technique in the project execution to fulfill the desired objectives.

Course Content:

UNIT–1 Introduction to Project Management [11 hrs]

Concept of Project Management: Concept of project, categories of projects, phase of project life cycle,roles and responsibility of a project leader, tools and technology for project management.

Organizing and Staffing: Project leader: skills/abilities required for project manager, authorities and responsibilities of project manager, project organization, types of accountability in project execution and control

UNIT – 2 Project Planning and Estimation [11 hrs]

Feasibility study and report, phased planning, project planning steps: objectives and goals of the project, preparation of cost estimation, finalization of project implementation, evaluation of the project profitability.

Project Procedure Manual: Contract management, configuration management, communication management, man management , time management, materials management, cost management, needs for flexibility

UNIT – 3 Project Scheduling, Coordination and Control [11 hrs]

Project implementation, scheduling-different techniques-GANTT charts for combined activities, Project direction, communication in a project, project coordination, project control, scope and progress control performance control, schedule control and cost control, case study .

UNIT – 4 Project Inventory Management [12 hrs]

Performance indicators, performance improvement for the CM and DM companies for better project management, nature of project inventory, supply and transportation of materials.

Project Implementation**:** project work system design, work break down structure (WBS), project execution plan (PEP)

Text Books:

1. Herold Kerzner **Project Management, a system approach to planning, scheduling and controlling**- CBS publishers and distributors, 2002
2. Chaudhry S **Project Management** McGraw Hill 2010

Reference Books:

1. Harvey Maylor **Project Management,** , 3rd edition, Pearson, 2003,

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
B18ME7062	**Automobile Engineering**	OE	4	0	0	4	4
Prerequisites: None		Internal Assessment			Semester End Exam		
		40 Marks			60 Marks		

Course Objectives:

1. To make the student understand about the various components of petrol engine and diesel engine.
2. To make the student understand about the various electrical components of an automobile necessary for Ignition system of an automobile.
3. To make the students understand the importance of emission control, alternate fuels and modifying the engine suitably
4. To make students to recognize the need for safety and comfort that need to be invoked in the system.

Course Outcomes:

By the end of the course, the student shall be able to,

1. Describe various aspects of automobile components and system which include engine components, fuel and ignition systems, transmission systems.
2. Demonstrate the various aspects of automobile components and suspension and braking systems and electrical and electronics system.
3. Describe the environmental implications of automobile emissions
4. Develop a strong base for understanding future developments in the automobile industry.

Course Content:

UNIT–1 Engine Components, Cooling and Lubrication [11 hrs]

Spark Ignition (SI) & Compression Ignition (CI) engines, cylinder – arrangements and their relatives merits, Liners, Piston, connecting rod, crankshaft, valves, valve actuating mechanisms, valve-Timing diagram, Types of combustion chambers for S.I.Engine and C.I.Engines, Compression ratio, methods of a Swirl generation, choice of materials for different engine components, engine positioning, cooling requirements, methods of cooling, thermostat valves.

Self-study: different lubrication arrangements.

UNIT–2 Fuel Supply and Emission Control System [11 hrs]

Fuel Supply System: Fuel supply in SI engines- Fuel mixture requirements for SI engines, Working principle of simple carburetors, Injection systems -Single-point body injection, multipoint fuel injection, Inline distributor pump, Individual control pump, Common rail, Unit injection fuel transfer pumps, Fuel filters, fuel injection pumps and injectors.

Engine Emissions And Control Systems: Automotive emission controls, Controlling crankcase emissions, Controlling evaporative emissions, Cleaning the exhaust gas, Controlling the air-fuel mixture, Controlling the combustion process, Exhaust gas recirculation, Air-injection system, Air-aspirator system, Catalytic converter, low temperature combustion (LTC), homogeneous charge compression ignition (HCCI).

Self-study: Emission standards, premixed charge compression ignition (PCCI).

UNIT–3 Ignition System and Transmission System [11 hrs]

Ignition System, Superchargers And Turbochargers: Introduction, objectives, Ignition System Types, Comparison between Battery and Magneto Ignition System, Drawbacks (Disadvantages) of Conventional Ignition Systems, Advantages of Electronic Ignition System, Types of Electronic Ignition System, Firing Order, Importance of Ignition Timing and Ignition Advance. Naturally aspirated engines, Forced Induction, Types of superchargers, Turbocharger and comparisons.

Transmission System: General arrangement of clutch, Principle of friction clutches, Torque transmitted, Fluid flywheel, Single plate, multi-plate and centrifugal clutches. Gear box: Necessity for gear ratios in transmission. Self-study: synchromesh gear boxes.

UNIT–4 Suspension, Braking and Steering System [12 hrs]

Suspension, Springs And Brakes: Requirements, Torsion bar suspension systems, leaf spring, coil spring, independent suspension for front wheel and rear wheel. Air suspension system. Types of brakes, mechanical compressed air, vacuum and hydraulic braking systems, construction and working of master and wheel cylinder, brake shoe arrangements, Disk brakes, drum brakes, Antilock –Braking systems, purpose and operation of antilock-braking system, ABS Hydraulic Unit, Rear-wheel antilock

Steering System: Steering geometry, camber, king pin inclination, included angle, castor, toe in & toe out, condition for exact steering, steering gears, power steering, general arrangements of links and stub axle, over steer, under steer and neutral steer.

Text Books:

1. Kirpal Singh, **Automobile Engineering**, Volume 1&2, Standard Publications.
2. R. B. Guptha **Automobile Engineering,** Satya Prakashan ,New Delhi

Reference Books:

1. William.H.Crouse, (2006), **Automotive Mechanics**, 10th Edition, McGraw-Hill.
2. Mathur and Sharma **Internal Combustion Engines** Dhanpat Rai& sons- India.
3. V Ganesan (2006), **Internal Combustion Engines**, 12th Edition, McGraw-Hill.

EIGHTH SEMESTER

Soft Core-9

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
B18ME8011	**Electric Vehicles and Hybrid Vehicles**	SC	3	0	0	3	3
Prerequisites: Basic Electrical Engineering, Applied Chemistry, Thermodynamics		Internal Assessment			Semester End Exam		
		40 Marks			60 Marks		

Course Objectives:

1. To present a comprehensive overview of conventional Vehicles.
2. To present a comprehensive overview of Electric and Hybrid Electric Vehicles.
3. To identify suitable communication and energy storage system for hybrid vehicles.
4. To recognize the importance of electric and hybrid electric vehicle in automobile industry.
5. To explore the future trends and applications of hybrid vehicles.

Course Outcomes:

By the end of the course, the student shall be able to

1. Identify difference between conventional and hybrid vehicles.
2. Elaborate and describe the various systems and features adopted for electric vehicles and hybrid electric vehicles.
3. Identify a suitable drive scheme for developing an electric hybrid vehicle depending on resources.
4. Detail basic schemes of electric vehicles and hybrid electric vehicles.
5. Select proper energy storage systems for vehicle applications.

Course Content:

UNIT -1: Conventional and Hybrid Electric Vehicles [11 hrs]

Conventional Vehicles: Basics of vehicle performance, vehicle power source characterization, transmission characteristic and mathematical models to describe vehicle performance
Hybrid Electric Vehicles: History of hybrid and electric vehicles, social and environmental importance of hybrid and electric vehicles, impact of modern drive-trains on energy supplies

UNIT -2: Drive-trains [11 hrs]

Hybrid Electric Drive-trains: Basic concept of hybrid traction, introduction to various hybrid drive-train topologies, power flow control in hybrid drive-train topologies, fuel efficiency analysis.
Electric Drive-trains: Basic concept of electric traction, introduction to various electric drive-train topologies, power flow control in electric drive-train topologies, fuel efficiency analysis.

UNIT -3 Electric Propulsion Unit and Energy Storage [11 hrs]

Electric Propulsion unit: Electric components used in hybrid and electric vehicles, Configuration and control of DC Motor drives, Configuration and control of Induction Motor drives
Energy Storage: Introduction to Energy Storage Requirements in Hybrid and Electric Vehicles, Battery based energy storage and its analysis, Fuel Cell based energy storage and its analysis, Hybridization of different energy storage devices

UNIT -4: Drive and Communications Systems [12 hrs]

Drive system: Matching the electric machine and the internal combustion engine (ICE), Sizing the propulsion motor, sizing the power electronics,
Communications, supporting subsystems: In vehicle networks- CAN, Energy Management Strategies: Energy management strategies used in hybrid and electric vehicles, classification of different energy management strategies, comparison of different energy management strategies
self-study: selecting the energy storage technology,.

Text Books:

1. Iqbal Hussein, **Electric and Hybrid Vehicles: Design Fundamentals**, CRC Press, 2003

Reference Books:

1. James Larminie, John Lowry, **Electric Vehicle Technology Explained**, Wiley, 2003
2. Mehrdad Ehsani, YimiGao, Sebastian E. Gay, Ali Emadi, **Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design**, CRC Press, 2004.

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
B18ME8012	**Advanced Foundry Technology**	SC	3	0	0	3	3
Prerequisites: Manufacturing Technology, Material science and Metallurgy.		Internal Assessment			Semester End Exam		
		40 Marks			60 Marks		

Course Objectives:

1. To study of facts and concepts of advanced foundry practices.
2. To examine the casting defects and remedial measures.
3. To analyze the casting design principles.

4. To introduce the various types of melting practices.

Course Outcomes:

By the end of the course students shall be able to:

1. Apply the knowledge to produce sound castings without defects and Differentiate between the different casting processes and their end products.
2. Describe molding, casting and solidification processes
3. Identify different methods of special molding techniques and decide the type of furnace suitable for melting of a particular type of metal
4. Apply the modern techniques to automate a foundry unit.

Course Content:

UNIT -1: Oxidation of Metals [11hrs]

Oxidation of liquid metals, gas dissolution in liquid metals, degassing methods , fluidity, factors affecting fluidity, fluidity tests, hot tearing, shrinkage of liquid metals.

Design of Castings: Introduction to casting design, redesign considerations, design for minimum casting stresses, design for directional solidification, design for metal flow, safety factors, design for low pattern cost and model making as an aid in design.

UNIT -2: Solidification of Castings [11 hrs]

Solidification of Castings: Crystallization and development of cast structure- nucleation, growth and dendritic growth. Structure of castings – significance and practical control of cast structure, grain shape and orientation, grain size, refinement and modification of cast structure. Concept of progressive and directional solidification.

Risering and Gating: Need for risering, riser shapes, riser size, and location. Requirements of a riser. Internal chills, external chills, padding for directional solidification. Gating system – theoretical consideration of gating, turbulence in gating system, need for tapered sprue, gating ratio.

UNIT -3: Special Moulding Techniques [11 hrs]

Special Moulding Techniques: Principles, materials used, process details and application of no-bake sand systems, vacuum molding, flask less molding, and high pressure molding.

Cupola Melting: Developments in cupola melting – hot blast cupola, water cooled cupola, balanced blast cupola, coke less cupola, cupola charge calculations.

UNIT -4: Ferrous and Non-Ferrous Foundry [12 hrs]

Ferrous and Non-Ferrous Foundry: Melting procedures, casting characteristics, production, specification, and properties of some typical steels and grey cast iron. Melting procedures, casting characteristics, production, specification, and properties of some typical aluminum, copper and their alloys.

Modernization and Mechanization of Foundry: Need for modernization, and mechanization, dust and fume control, material handling equipment's for sand molds and cores, molten metal and castings, reclamation of sands.

Text Books:

1. Heine Loper& Rosenthal **Principles of Metal Casting**, TMH– 2005.
2. P. L. Jain, **Principles of Foundry Technology**, 5th Ed., TMH – 2006

Reference Books:

1. John Campbell, **Castings**,Second edition, Elseivier.
2. P. N. Rao. **Foundry Technology**,
3. Dr. K. Radha Krishna **Manufacturing Process-I,** 5th Edn. Sapna Book House, Bangalore.

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
B18ME8013	**Additive Manufacturing**	SC	3	0	0	3	3
Prerequisites: None		Internal Assessment			Semester End Exam		
		40 Marks			60 Marks		

Course Objectives:

1. To learn the fundamentals of Rapid prototyping and related concepts to understand the various materials used in the techniques.
2. To minimize sustaining engineering changes
3. To extent product life time by adding necessary features and eliminating redundant features early in the design.
4. To have a hands on experience on various tools used for modeling and manufacturing aspects of RP
5. To understand the role of rapid prototyping and rapid tooling.
6. To study about the programming aspects by using machine code languages for various operations using sophisticated software's (Manual and computer aided part programming)

Course Outcomes:

By the end of the course the students shall be able to

1. Differentiate between conventional and rapid prototyping approach.
2. Apply the various techniques in order to produce Prototypes pattern development for rapid tooling and various RP software.
3. Ascertain the impact of Rapid prototyping, Rapid tooling and Rapid manufacturing in the product development process.
4. Describe the communication of the product as a tool.

Course Content:

UNIT- 1 Introduction and SLA [11 hrs]

Definition of RP, Prototypes, Types of prototypes, roles of prototypes, Need for the compression in product development, Impact of Rapid prototyping in product development, history of RP systems, Survey of applications, industry and classification of RP systems, Basic methodology of RP, Benefits and limitations.

Stereo Lithography Systems: Principle, Process parameter, Process details, Data preparation, data files and machine details, Application.

UNIT -2 Techniques of RP [11 hrs]

Solid Ground Curing: Principle of operation, Machine details, Applications

Selective Laser Sintering: Type of machine, Principle of operation, process parameters, Data preparation for SLS, Applications.

Fusion Deposition Modeling: Principle, Process parameter, Path generation, Applications.

Laminated Object Manufacturing: Principle of operation, LOM materials. Process details, application.

UNIT -3 Concept Modelers and Rapid Tooling [11 hrs]

Concepts Modelers: Principle, Thermal jet printer, Sander's model maker, 3-D printer. object Quadra systems.

Rapid Tooling: Indirect Rapid tooling, Silicon rubber tooling, Aluminium filled epoxy tooling, Spray metal tooling, 3D keltool, etc. Direct Rapid Tooling, Quick cast process, Copper polyamide, Rapid Tool, DMILS, , Sand casting tooling, Laminate tooling soft Tooling vs. hard tooling.

Software for RP: STL files, Overview of Solid view, magic's, Mimics, magic communicator, etc.. Internet based manufacturing

UNIT -4 Process Optimization and Reverse Engineering [12 hrs]

Process Optimization: factors influencing accuracy. Data preparation errors, Part building errors, Error in finishing, influence of build orientation.

Reverse Engineering: surface digitizing, Surface generation from point cloud data, surface modification – data transfer to solid models. Detail application with respect to Aerospace, medical, and automobile industry.

Text Books:

1. Paul F. Jacobs **Stereo Lithography and other RP & M Technologies**,: SME, NY 1996.
2. Pham D.T & Dimov, S.S Verlog **Rapid Manufacturing**, S.S Verlog London 2001

Reference Books:

1. Terry Wohlers **Rapid Prototyping**, Wohler's Report 2000" Wohler's Association 2000.
2. Gurumurthi, **Rapid Prototyping Materials**, IISc Bangalore
3. Lament wood. **Rapid Automated**, Indus press New York

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
B18ME8014	**New Venture Planning and Management**	SC	3	0	0	3	3
Prerequisites: None		Internal Assessment			Semester End Exam		
		40 Marks			60 Marks		

Course Objectives:

1. To enable the students have an overall view of new venture initiation
2. To provide students with intricacies of new venture management
3. To teach students about details of financing how to get governmental assistance
4. To introduce students to the legal aspects of business

Course Outcomes:

By the end of the course student shall be able to

1. Explain the concept of entrepreneurship.
2. Describe the business plan.

3. Estimate the finance required for start the business.
4. Illustrate the various legal aspects should known by the entrepreneur.

Course Content:

UNIT -1: Business Concepts [11hrs]

Entrepreneurship – Meaning – Types – Qualities of an Entrepreneur, Factors influencing Entrepreneurship. Entrepreneurship as a career. Business Concept – Statement of concept of business – Who is the potential customer – Concept development —Where the money is– Appropriate trend analysis (trend identification) – Micro\ Macro level factors - Social - political - environmental - demographic - international factors – Tap customer's hidden requirements – Competitor effect .

UNIT -2: Business Plan [11hrs] Contents of Business plan- Introduction, Project details, Project projections Characteristics of project- General and Technical, Project cost, Production cost, Financial details, Break even Analysis, Profitability. Sample plan. Sales and marketing- Market Survey, market research, Marketing approach, channels of distribution. Pricing for profitability.

UNIT -3 Financing [11 hrs]

Financing your business – Estimating your financial requirements – Pre-operative expenses - Fixed - Working capital - Sources of fund – Promoter's capital - Debt Equity ratio – Margin Money - Venture Capital – Shares and related issues – Governmental organization– Marketing expenses - Office expenses – Cash flow statement – Break even – Profit planning – Project preparation.

UNIT -4: Legal Aspects of Business and Governmental Assistance [12 hrs]

Legal aspects of business: - Relating to Registration, labour – Licenses – clearances. Intellectual property rights - Advertising issues – Business insurance. Employee welfare measures – PF - ESI - Medical compensation - Risk coverage – Accounting practices –Income Tax – VAT – TDS.

Governmental Assistance – Local – DIC –Government subsidies Grants and schemes for entrepreneurship development, Entrepreneurial Development Agencies. Environmental aspects and Safety.

Text Books:

1. **Hand Book for New Entrepreneurs**, (2008), P.C Jain Entrepreneurship Institute of India, Ahmadabad, India

Reference Books:

1. Harold. P. Welsch, (2003) **The Entrepreneurship: The way ahead**.
2. David. F. Summen, (2000), **Forming Entrepreneurial Institution**.
3. Sramana Mitra (2008) **Entrepreneur Journeys**.

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
B18ME8015	**Project Management**	SC	3	0	0	3	3
Prerequisites: None		Internal Assessment			Semester End Exam		
		40 Marks			60 Marks		

Course Objectives:

1. To provide the knowledge of project management, methodology
2. To know the use of project management tools, techniques and skills.
3. To give knowledge to manage the project cost, quality and delivery.
4. To learn the skill of selection and initiation of individual projects and portfolios of projects in the enterprise.

.**Course Outcomes:**

By the end of the course the student shall be able to

1. Identify specific management needs in the execution of projects at tactical and strategic level.
2. Estimate the project proposals for scope, time and cost to consider its feasibility.
3. Synthesis the strategies to evolve suitable approach to accomplish the project with effective usage of the resources.
4. Illustrate the team building and leadership skills in planning and implementation of the project.
5. Apply effective management technique in the project execution to fulfill the desired objectives.

Course Content:

UNIT–1 Introduction to Project Management [11 hrs]

Concept of Project Management: Concept of project, categories of projects, phase of project life cycle,roles and responsibility of a project leader, tools and technology for project management.

Organizing and Staffing: Project leader: skills/abilities required for project manager, authorities and responsibilities of project manager, project organization, types of accountability in project execution and control

UNIT– 2 Project Planning and Estimation [11 hrs]

Feasibility study and report, phased planning, project planning steps: objectives and goals of the project, preparation of cost estimation, finalization of project implementation, evaluation of the project profitability.

Project Procedure Manual: Contract management, configuration management, communication management, man management , time management, materials management, cost management, needs for flexibility

UNIT– 3 Project Scheduling, Coordination and Control [11 hrs]

Project implementation, scheduling-different techniques-GANTT charts for combined activities, Project direction, communication in a project, project coordination, project control, scope and progress control performance control, schedule control and cost control, case study.

UNIT– 4 Project Inventory Management [12 hrs]

Performance indicators, performance improvement for the CM and DM companies for better project management, nature of project inventory, supply and transportation of materials.

Project Implementation**:** project work system design, work break down structure (WBS), project execution plan (PEP)

Text Books:

1. Herold Kerzner **Project Management, a system approach to planning, scheduling and controlling**- CBS publishers and distributors, 2002
2. Chaudhry S **Project Management** McGraw Hill 2010

Reference Books:

1. Harvey Maylor **Project Management,** , 3rd edition, Pearson, 2003,

Soft Core-10

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
B18ME8021	**Energy Audit and Management**	SC	3	0	0	3	3
Prerequisites: Engineering Thermodynamics		Internal Assessment			Semester End Exam		
		40 Marks			60 Marks		

Course Objectives:

1. To provide students with fundamental concepts of energy conversion in engineering.
2. To acquire knowledge in various types of energy and their applications.
3. To import knowledge on various utilization techniques.
4. To import knowledge on various energy audit technique.
5. To describe total energy produced and utilized.

Course Outcomes:

By the end of the course the student shall be able to

1 Explain energy conversion processes.
2. Gain knowledge on forms of energy in various field.
3. Gain knowledge on conversion technique.
4. Gain knowledge on energy management technique.
5. Gain knowledge energy produced and utilized

Course Content:

UNIT -1 Global Energy Scenario [11 hrs]

Role of energy in economic development and social transformation: Energy & GDP, GNP and its dynamics. Introduction, Sources of Energy – Conventional and Non-Conventional, Elasticity of demand and Application, concepts to energy, Solar energy, water, battery and Mechanical Storage Systems.

UNIT -2 Energy Utilization and Conversion System [11 hrs]

Classification of furnaces, controlled atmosphere in furnaces, furnace fuels, efficient use of energy I in furnaces, thermal efficiency, reducing heat losses. Combined Power and Heating System Characteristics of prime movers, Heat and Power requirements, Economics of a CHP System.

UNIT -3 Energy Audit [11 hrs]

Energy Management information system, Thirty nine steps for energy management, types of energy audit, preliminary energy audits, and Technical assistance in energy audit, energy accounting and analysis, Instruments used in Energy auditing.

UNIT -4 Energy Management [12 hrs]

Introduction, Economics, Discounted Cash flow, Loans, Investments, Option Identification and Analysis, Optimization, Conflict Correction, Constructing the Optimal Target Investment Schedule, Project Management, Monitoring Against the Target Financial Schedule.

Text Books:

1. Kao Chen – **Energy Management in illuminating System** – CRC Publishers
2. Jose Goldenberg, Thomas Johansson, A.K.N.Reddy, Robert Williams **Energy for a sustainable world:** Wiley Eastern.

Reference Books:

1. Archie W. Culp – Jr. **Principles of Energy Conversion** – International Student Edition – McGraw Hill Publishers

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
B18ME8022	**Advanced Machine Design**	SC	3	0	0	3	3
Prerequisites: TOE, TOP and DME		Internal Assessment			Semester End Exam		
		40 Marks			60 Marks		

Course Objectives:

1. Knowledge of different modes of failures &fatigue behavior of materials
2. To identify the Life estimation and stress component subjected to finite and infinite life.
3. Introduction to fracture mechanics and stress intensity factor.
4. Understand different damage tolerant theories used to estimate life and Types of surface failures, contact stresses.

Course Outcomes:

By the end of the course, the student shall be able to,

1. Classify and explain the art of design methodology by analysis and damage tolerance methods.
2. Discuss an overview of mechanical behavior which includes tensile, fatigue and creep.
3. Illustrate the micro mechanisms of brittle and ductile fracture.
4. Examine the fatigue and fracture behavior of materials.

Course Content:

UNIT -1 Introduction and Fatigue Behavior of Materials [11 hrs]

Introduction: Role of failure prevention analysis in mechanical design, Modes of mechanical failure, Review of failure theories for ductile and brittle materials including Mohr's theory and modified Mohr's theory, Numerical examples.

Fatigue behavior of materials: Introductory concepts, High cycle and low cycle fatigue, Fatigue design models, Fatigue design methods, Fatigue design criteria, Fatigue testing, Test methods and standard test specimens, Fatigue fracture surfaces and macroscopic features, Fatigue mechanisms and microscopic features.

UNIT -2 Stress-life (S-N) Approach and Strain-life (ε-N) Approach [11 hrs] **Stress-life (S-N) approach:** S-N curves, Statistical nature of fatigue test data, General S-N behavior, Mean stress effects, Different factors influencing S-N behavior, S-N curve representation and approximations, Constant life diagrams, Fatigue life estimation using S-N approach. Monotonic stress-strain behavior, Strain controlled test methods, Cyclic stress-strain behavior, Strain based approach to life estimation,

Strain-life (ε-N) approach: Determination of strain life fatigue properties, mean stress effects, Effect of surface finish, Life estimation by S-N approach.

UNIT -3 Linear Elastic Fracture Mechanics and Residual Stresses [11 hrs]

LEFM: LEFM concepts, Crack tip plastic zone, Fracture toughness, Fatigue crack growth, Mean stress effects, Crack growth life estimation. Definitions of types of fracture and failure, Introduction to stress intensity factor and strain energy release rate, stress intensity approach.

Residual Stress: Introduction, production of residual stresses & fatigue resistance, relaxation of residual stresses, measurement of residual stresses, stress intensity factors for residual stresses, applications.

UNIT -4 Fatigue from Variable Amplitude Loading [12 hrs]

Spectrum loads and cumulative damage, Damage quantification and the concepts of Damage fraction and accumulation, Cumulative damage theories, Load interaction and sequence effects, Cycle counting methods, Life estimation using stress life approach.

Text Books:

1. R. I. Stephens, A. Fatemi, R. R. Stephens, H. Fuchs, **Metal Fatigue in Engineering**, John Wiley Newyork, 2nd edition, 2001.
2. J. A. Collins, JWiley, **Failure of Materials in Mechanical Design**, Newyork, 1992.
3. R. L. Norton, **Machine Design**, Pearson Education India, 2000.

Reference Books:

1. S. Suresh, **Fatigue of Material**, Cambridge University Press, 1998.
2. J. A. Benantine, **Fundamentals of Metal Fatigue Analysis**, Prentice Hall, 1990.
3. **Fatigue and Fracture**, ASM Hand Book, Vol 19, 2002.

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
B18ME8023	MEMS	SC	3	0	0	3	3
Prerequisites: None		Internal Assessment			Semester End Exam		
		40 Marks			60 Marks		

Course Objectives:

1. To study the fundamentals of MEMS and micro fabrication.
2. To identify the essential of MEMS material properties.
3. To distinguish various sensing and transducer techniques.
4. To select various fabrications and machining process of MEMS as per application.

Course Outcomes:

By the end of the course student shall be able to

1. Elaborate the important concepts applicable to MEMS, their fabrication.
2. Analyze the material properties used in MEMS.
3. Apply the MEMS for different applications.
2. Explain the working principle of micro sensors and micro actuators.

Course Content:

UNIT-1 Applications of MEMS [11 hrs]

Unique characteristics of MEMS, Microsystems Technology- An Overview, typical MEMS and Microsystems Products.

Applications of MEMS - Scaling effects - scaling laws in miniaturization- Application of MEMS and Microsystems- Future Directions of MEMS.

UNIT -2 Material for MEMS and Manufacturing [11hrs]

Structure of silicon and other materials - Silicon wafer processing - Bulk micromachining and Surface micromachining, Wafer-bonding. Thin-film deposition, Lithography, wet etching and dry etching.

UNIT -3 Micro-Fabrication Methods [11 hrs]

LIGA and other molding techniques- Soft lithography and polymer processing- Thick-film processing; Low temperature co-fired ceramic processing-.Smart material processing.

UNIT -4 MEMS Components-Micro Sensors and Micro-Actuators [12 hrs]

Micro sensors - Basic principles and working of micro sensors- Acoustic wave micro sensors- Bio-medical micro sensors- Bio-sensors- Chemical micro sensors – Optical Sensors – Pressure micro sensors- Thermal micro sensors-acceleration micro sensors.

Micro actuators - Basic principles and working of micro actuators- Electrostatic micro actuators- Piezoelectric micro actuators- Thermal micro actuators- SMA micro actuators- Electromagnetic

micro actuators, micro valves, micro pumps.

Text Books:

1. Tai-Ran-Hsui (2013), **MEMS & Microsystems: Design and Manufacture**, McGraw Hill, 17th Reprint.

Reference Books:

1. Nadim Maluf and Kirt Williams (2004), **An Introduction to Microelectro mechanical Systems Engineering,** Second Edition, Artech House Print on Demand, ISBN-13 978-1580535908.
2. Stephen R.Santuria (2001), **Microsystem Design,** Springer Science-Business Media Inc.
3. Minhang Bao (2005), **Analysis and Design Principles of MEMS devices**,Elsevier.
4. Marc J. Madou (2002), **Fundamentals of Micro Fabrication: The Science of Miniaturization,** Second Edition, CRC.
5. Nitaigour Premchand Mahalick (2007), **MEMS,** Tata McGraw Hill.

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
B18ME8024	**Total Quality Management**	SC	3	0	0	3	3
Prerequisites: None		Internal Assessment			Semester End Exam		
		40 Marks			60 Marks		

Course Objectives:

1. To provide the knowledge of quality and its evolution
2. To introduce the basics of leadership and customer perception of quality
3. To impart the knowledge of quality tools
4. To attain the knowledge of six sigma and its methodology

Course Outcomes:

By the end of the course the student shall be able to

1. Define quality and its importance and adopt leadership requirements
2. Explore the various dimensions of customer
3. Use various quality tools for addressing quality issues
4. Design for six sigma to enhance the quality.

Course Content:

UNIT -1 Principles and Practices [11 hrs]

Basic approach, gurus of TQM, TQM frame work, awareness, defining quality, historical review, obstacles, benefits of TQM.

Leadership: Definition, characteristics of quality leaders, leadership concepts, Deming philosophy, role of TQM leaders, implementation, strategic planning communication, decision making.

UNIT -2: Customer Satisfaction and Customer Involvement [11 hrs]

Customer perception of quality, feedback using customer complaints, service quality, translating needs into Requirements, customer retention. Employee involvement - Motivation, employee surveys,

Empowerment teams, suggestion system, recognition and reward, gain sharing, performance appraisal, unions and employee involvement.

UNIT -3 Continuous Process Improvement [11 hrs]

Juran triology, improvement strategies, PDCA cycle, problem solving methods, Kaizen, 5S concepts, reengineering, six sigma. Tool and Techniques - Statistical process control-7QC tools, Benching marking, information technology, quality management systems, QFD, FMEA, product liability, Total productive maintenance. TQMEX model.

UNIT -4 Quality Management Tools and Design of Six Sigma [12 hrs]

Forced filed analysis, nominal group techniques, affinity diagram, interrelationship digraph, tree diagram, matrix diagram, process decision program chart and activity network diagram.

Design for six sigma: tools for concept development, tools for design development, tools for design optimization, tools for design verification problems.

Text Books:

1. Dale H.Bester field, **Total quality Management:** Publisher- Pearson Education India, ISBN: 8129702606.
2. M.Zairi, ISBN: 1855730243, **Total quality Management for Engineers:** Publisher: Wood head publishing.

Reference Books:

1. Shoji shiba, Aln Graham, David Walden**, A new American TQM, four revolutions in management,** Productivity Press, Orgeon, 1990.
2. Gopal K.Kanji and Mike Asher, **100 Methods for TQM**: ISBN: 083977476, Publisher: sage publications, Inc: Edition-I
3. H.Lal, **Organizational excellence through TQM** New age Publication,

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
B18ME8025	**Internship**	SC	0	0	3	3	--
Prerequisites: None		Internal Assessment			Semester End Exam		
		40 Marks			60 Marks		

Course Objectives:

1. To give exposure to industrial activities.
2. To learn various aspects of activities carried out in industry.
3. To understand application of concepts of mechanical engineering in industry.
4. To know various process and machines used to make a product.
5. To gain overall idea about industry.

Course Outcomes:

By the end of the course the student shall be able to

1. Explain various aspects of industry.
2. Explain some of the process used to make a product.
3. Explain the management concept used in particular industry.

4. Explain the activities of the particular industry

Student should do internship for 21 days in one stretch or 15 days in two stretches at the end of the 6th semester. After completion submit the 20 page report on internship and give presentation.

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
B18ME8030	**PROJECT**	HC	0	0	8	8	--
Prerequisites: None		Internal Evaluation			Semester End Evaluation		
		50 Marks			50 Marks		

Course Objectives:

1. To identify the problem in real time application and find out the solution
2. To make the students to convert their ideas in to reality.
3. To develop the skill of writing, documentation and presentation.

Course Outcomes:

After completion of the course the student shall be able to

1. Identify the problems in the real time application.
2. Apply the knowledge to analyze the problem.
3. Document the progression of the work and results.
4. Design the process/ product for simple applications.

The students have to make a project team of minimum two candidates to maximum of four candidates and select the problems from an industry or in the society or any innovative ideas. The project team has to work for the solution or converting their ideas into product and present the progress of the work in two phases which will be evaluated for 50 marks. At the end of the semester the students have to submit the hard copy of the report which will be prepared as per the guidelines/format of the university. Semester end evaluation will be conducted batch wise.

Career Development and Placement

Having a degree will open doors to the world of opportunities for you. But Employers are looking for much more than just a degree. They want graduates who stand out from the crowd and exhibit real life skills that can be applied to their organizations. Examples of such popular skills employers look for include:

- Willingness to learn
- Self motivation
- Team work
- Communication skills and application of these skills to real scenarios
- Requirement of gathering, design and analysis, development and testing skills
- Analytical and Technical skills
- Computer skills
- Internet searching skills
- Information consolidation and presentation skills
- Role play
- Group discussion, and so on

REVA University therefore, has given utmost importance to develop these skills through variety of training programs and such other activities that induce the said skills among all students. A full-fledged Career Counseling and Placement division, namely Career Development Center (CDC) headed by well experienced senior Professor and Dean and supported by dynamic trainers, counselors and placement officers and other efficient supportive team does handle all aspects of Internships and placements for the students of REVA University. The prime objective of the CDC is to liaison between REVA graduating students and industries by providing a common platform where the prospective employer companies can identify suitable candidates for placement in their respective organization. The CDC organizes pre-placement training by professionals and also arranges expert talks to our students. It facilitates students to career guidance and improve their employability. In addition, CDC forms teams to perform mock interviews. It makes you to enjoy working with such teams and learn many things apart from working together in a team. It also makes you to participate in various student clubs which helps in developing team culture, variety of job skills and overall personality.

The need of the hour in the field of Commerce is efficient leaders of repute, who can deal the real time problems with a flavour of innovation. This kept in focus, the CDC has designed the training process, which will commence from second semester along with the curriculum. Special coaching in personality development, career building, English proficiency, reasoning, puzzles, leadership, and strategic management and communication skills to every student of REVA University is given with utmost care. The process involves continuous training and monitoring the students to develop their soft skills including interpersonal skills that will fetch them a job of repute in the area of his / her interest and march forward to make better career.

The University has recognized skill development and industry relationship as its very important activities. Therefore, the University-Industry Interaction and Skill Development Centre headed by a Senior Professor & Director has been established to facilitate skill related training to REVA students and other unemployed students around REVA campus. The center conducts variety of skill development programs to students to suite to their career opportunities. Through this skill development centre the students shall compulsorily complete at least two skill / certification based programs before the completion of their degree. The University has collaborations with Industries, Corporate training organizations, research institutions and Government agencies like NSDC (National Skill Development Corporation) to conduct certification programs. REVA University has been recognised as a Centre of Skill Development and Training by NSDC (National Skill Development Corporation) under Pradhan Mantri Kaushal Vikas Yojana.

The various skill/certification programs identified are as follows:

- Big-data and Cloud Computing, Internet of Things (IOT), ORACLE, MYSQL, Advanced Java and Internals of LINUX/UNIX
- Red-hat certified programs on LINUX,
- Management related programs like SAP,ERP and Business Analytics
- Open Source software/hardware, Software Testing
- Advanced networking based CISCO / Microsoft technology.
- Web designing, System administration
- IBM certified programs.

The University has signed MOU's with Multi-National Companies, research institutions, and universities abroad to facilitate greater opportunities of employability, students' exchange programs for higher learning and for conducting certification programs.

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DO'S AND DON'TS

DO'S

1. Maintain discipline and respect the rules and regulations of the university
2. Be regular and punctual to classes
3. Study regularly and submit assignments on time
4. Be respectful to your Teaches/friends and hostel staff/management.
5. Read the notice board (both at your college and the hostel) regularly.
6. Utilize your Personal Computer for educational purpose only.
7. Follow the code of conduct.
8. Visit Health Center on the campus whenever you are unwell.
9. Be security conscious and take care of your valuables especially Cash, Mobile Phones, Laptop and other valuables.
10. Carry your valuables along with you whenever you proceed on leave/vacation.
11. Use electric appliances, lights and water optimally.
12. Keep the campus clean and hygienic.
13. Use decent dressing.

DON'TS

1. Ragging inside / outside the campus.
2. Possession of Fire arms and daggers etc.
3. Use of Alcohols, Toxic drugs, sheesha, gutkha and hashish/heroin etc.
4. Use of Crackers, explosives and ammunition etc.
5. Smoking and keeping any kind of such items.
6. Misusing college & hostel premises/facilities for activities other than studies.
7. Playing loud music in the room which may disturb studies of colleagues / neighbours.
8. Making noise and raising slogans.
9. Keeping electrical appliances, other than authorized ones.
10. Involvement in politics, ethnic, sectarian and other undesirable activities.
11. Proxy in any manner.
12. Use of mobiles in the academic areas.

Note: 1. Rules are revised / reviewed as and when required.

2. Healthy suggestions are welcome for betterment of Institution