REVA UNIVERSITY
Bengaluru, India

SCHOOL OF MECHANICAL ENGINEERING

M.Tech

in

Machine Design

HAND BOOK

2017-19

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

School of Mechanical Engineering

M.Tech. in
Machine Design

HAND BOOK

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Approved by Board of Studies

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Rukmini Educational
Charitable Trust

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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. 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

With great pleasure, I welcome you to the PG Studies under the School of Mechanical Engineering. The School offers Undergraduate program in Mechanical Engineering leading to B. Tech., Degree, in addition to Master's program leading to M. Tech. degree in Machine Design. More than 1500 students representing various parts of India as well as few students from overseas study at our School. The School has more than 60 well qualified and experienced faculty members. The School has modern teaching, learning, innovation and research facilities in addition to excellent facilities for recreation and sports. Students are encouraged to live in campus to have better campus experience and our hostel facilities are second to none.

We understand that the students come to university for learning and the School focuses on enhancing the efficiency of learning of students and also achieving the learning outcomes to pursue careers in modern day industries. To improve efficiency of learning, the School has successfully adopted modern day pedagogical methods like project based learning, problem based learning, blended learning, flipped class rooms, experiential learning and created digital resources for students to access and experience. The faculty members of the School continuously upgrade their pedagogical methods and knowledge to be in par with the best in the Country. Our students are very successful in developing and demonstrating technologically advanced projects during their final year.

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.

Our masters and Ph.D Scholars work on scientifically and technologically advanced topics in Mechanical Design, Engineering Analysis, Manufacturing of Mechanical and Mechatronic Systems and publish their research findings in international journals of repute.

The School has created an excellent ambience conducive for innovation, creativity and interaction. Faculty mentors and senior students instill confidence in the junior students and motivate them to achieve higher goals. The students are given support for their industry internship, placements, study abroad, industry projects and interaction with industry mentors.

I am sure that students choosing M.Tech. (Machine Design) will benefit a lot from the industry based curriculum, teaching and learning environment, vast infrastructure, teacher's involvement and guidance.
I wish all PG students a pleasant and exploring stay in REVA University and grand success in their career.

Dr.K.S.Narayanaswamy
Director-School of Mechanical Engineering

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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, Architecture, Commerce, Education, Engineering, Environmental Science, Legal Studies, 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 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 Arts, Architecture, Commerce, Education, Engineering, Environmental Science, Legal Studies, Management 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 notched 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 Ph.D degrees. REVA has well qualified experienced teaching faculty of whom majority are doctorates. The faculty is supported by committed administrative and technical staff. Over 15,000 students study various

courses across REVA's three campuses equipped with exemplary state-of-the-art infrastructure and conducive 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 7thFebruary, 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 12000+ students studying in various branches of knowledge at graduate and post graduate level and 431 Scholars pursuing research leading to PhD in 21 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 allprograms 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, Nano Tribology, Fuel Mechanics, Operation Research, Graph theory, Strategic Leadership and Innovative Entrepreneurship, Functional Development Management, Resource Management and Sustainable Development, CyberSecurity, 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 VikasYojana. 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, Okalahoma 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 concentrateson training entire faculty to adopt the new tools and implement their use. The division further works on introducing various examination and administrative reforms.

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 honored with many more such honors and recognitions.

Vision

REVA University aspires to become an innovative university by developing excellent human resources with leadership qualities, ethical and moral values, research culture and innovative skills through higher education of global standards.

Mission

- To create excellent infrastructure facilities and state-of-the-art laboratories and incubation centers
- To provide student-centric learning environment through innovative pedagogy and education reforms
- To encourage research and entrepreneurship through collaborations and extension activities
- To promote industry-institute partnerships and share knowledge for innovation and development
- To organize society development programs for knowledge enhancement in thrust areas
- To enhance leadership qualities among the youth and enrich personality traits, promote patriotism and moral values.

Objectives

- Creation, preservation and dissemination of knowledge and attainment of excellence in different disciplines
- Smooth transition from teacher - centric focus to learner - centric processes and activities
- Performing all the functions of interest to its major constituents like faculty, staff, students and the society to reach leadership position
- Developing a sense of ethics in the University and Community, making it conscious of its obligations to the society and the nation
- Accepting the challenges of globalization to offer high quality education and other services in a competitive manner

ABOUT 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 equipment 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 Ph.D 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**

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M.Tech. in Machine Design

Program Overview

Mechanical Engineering discipline applies the principles of physics and materials science for design, analysis, prototyping, manufacturing, and maintenance of mechanical systems. Mechanical Engineers specialize in subject areas like Machine Design, Manufacturing and Energy Conversion (Thermal power) depending on individual's interest through postgraduate education and research routes.

The School of Mechanical Engineering at REVA UNIVERSITY offers M. Tech., in Machine Design–a postgraduate program to create motivated, innovative, creative and thinking graduates to fill the roles of Machine Designers who can conceptualize, design, analyze and develop machines to meet the modern day requirements.

The first intellectual and creative activity in development of a new equipment is product or industrial design and the subsequent activity is the Machine Design. Machine design is the process of engineering design. It is about recognizing the need, arriving at specifications, synthesis, analysis, prototyping and evaluation and producing drawings for manufacturing.

Mechanical engineers work in the domains of automobile engineering, aerospace engineering, machine tools, Internal combustion engines, cement industry, steel industries, power sector, hydraulics, manufacturing plants, drilling and mining industry, petroleum, general engineering, biotechnology and many more. Nowadays they are also increasingly needed in the environmental and bio-medical fields. Students completing M. Tech. in Machine Design program will have ample opportunities in premier research organizations like DRDO, ISRO, HAL, NAL and other CSIR institutions. Many OEM's, MNCs and private companies like SAFRAN, ALTAIR, GE, BOEING, AIRBUS, TATA MOTORS etc., are looking for the dynamic post-graduate candidates specialized in design aspects with CAE based software packages.

This handbook presents the M.Tech. Curriculum for Machine Design Program. The program is of 2 years duration and spilt into 4 semesters. The student admitting to this program has to earn 96 credits spread across four semesters to obtain the M.Tech degree. These credits are split into Hard Core (HC), Soft Core (SC) , Open Elective (OE).

The important features of M.Tech. in Machine Design are as follows:

1. Choice Based Course Selection (CBCS system).
2. Curriculum framed and taught by senior most faculty members.
3. Research based academic projects.

In this context, The School of Mechanical Engineering at REVA UNIVERSITY would like to add to the growing human resources needs of industry as machine designers through its M. Tech. program in Machine Design.

Program Educational Objectives (PEOs)

The aim of the program is to produce postgraduates with advanced knowledge and understanding of contemporary machine design; higher order critical, analytical, problem solving and transferable skills; ability to think rigorously and independently to meet higher level expectations of industry, academics, research establishments or take up entrepreneurial route.

The **Program Educational Objectives** are to prepare the students to:

The programme educational objectives of the M.Tech. in Machine Design of REVA University are to prepare graduates to

PEO1: Be machine designers to design mechanical equipment, machines and mechanical systems as per the desired customer specifications.

PEO2: Pursue doctoral research degree to work in colleges, universities as professors or as scientists in research establishments.

PEO3: Act as administrators in public, private and government organizations or business administrator or entrepreneur after further training.

Program Outcomes (POs)

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

PO1: Demonstrate in-depth knowledge of Machine Design, including wider and global perspective, with an ability to discriminate, evaluate, analyze and synthesize existing and new knowledge on design concepts, and integration of the same for enhancement of knowledge.

PO2: Analyze complex design problems critically, apply independent judgment for synthesizing information to make intellectual and/or creative advances for conducting research in a wider theoretical, practical and policy context.

PO3: Think laterally and originally, conceptualize and solve mechanical design problems, evaluate a wide range of potential solutions for those problems and arrive at feasible,

optimal solutions after considering public health and safety, cultural, societal and environmental factors in the core areas of expertise.

PO4: Extract information pertinent to unfamiliar problems through literature survey and experiments, apply appropriate research methodologies, techniques and tools, design, conduct experiments, analyze and interpret data, demonstrate higher order skill and view things in a broader perspective, contribute individually/in group(s) to the development of scientific/technological knowledge in the domains of mechanical design engineering.

PO5: Create, select, learn and apply appropriate techniques, resources, and modern engineering and IT tools, including prediction and modeling, to complex mechanical design engineering activities with an understanding of the limitations.

PO6: Possess knowledge and understanding of group dynamics, recognize opportunities and contribute positively to collaborative-multidisciplinary scientific research, demonstrate a capacity for self-management and teamwork, decision-making based on open-mindedness, objectivity and rational analysis in order to achieve common goals and further the learning of themselves as well as others.

PO7: Demonstrate knowledge and understanding of engineering and management principles and apply the same to one's own work, as a member and leader in a team, manage projects efficiently in mechanical design and multidisciplinary environments after consideration of economical and financial factors.

PO8: Communicate with the engineering community, and with society at large, regarding complex mechanical design engineering activities confidently and effectively, such as, being able to comprehend and write effective reports and design documentation by adhering to appropriate standards, make effective presentations, and give and receive clear instructions.

PO9: Recognize the need for, and have the preparation and ability to engage in life-long learning independently, with a high level of enthusiasm and commitment to improve knowledge and competence continuously.

PO10: Acquire professional and intellectual integrity, professional code of conduct, ethics of research and scholarship, consideration of the impact of research outcomes on professional practices and an understanding of responsibility to contribute to the community for sustainable development of society.

PO11: Observe and examine critically the outcomes of one's actions and make corrective measures subsequently, and learn from mistakes without depending on external feedback (SELF learning).

PROGRAM SPECIFIC OUTCOMES (PSOs)

After successful completion of the programme, the post graduates shall be able to

PSO 1: Apply Machine Design engineering knowledge, skills and competency in Design and analysis of systems related to Automotive, Mechanical, Aerospace Engineering and allied areas to obtain realistic outcomes.

PSO 2: Identify, formulate, analyze and solve problems in mechanical design engineering and allied domains.

PSO 3: Conduct investigations in the areas of numerical analysis, vibration analysis, material failure, mechanism synthesis to provide optimal and sustainable solutions.

M.Tech. (Machine Design) Program
Scheme of Instruction
(Effective from the Academic Year 2017-18)

SI No	Course Code	Title of the course	Types of course (HC/SC)	Credit Pattern			Credit Value	Total Hours
				L	T	P		
FIRST SEMESTER								
1	MTMD17F110	Computational Methods	HC	4	1	0	5	6
2	MTMD17F120	Design of Mechanisms	HC	4	1	0	5	6
3	MTMD17F130	Theory of Elasticity	HC	4	1	0	5	6
4	MTMD17F141	Gear Design	SC	4	1	0	5	6
	MTMD17F142	Design of Experiments		4	1	0		
	MTMD17F143	Failure Analysis and Design		4	1	0		
5	MTMD17F151	Rotor Dynamics	SC	4	1	0	5	6
	MTMD17F152	Design for Manufacturing		4	1	0		
	MTMD17F153	Computer Graphics		4	1	0		
6	MTMD17F161	Tribology	SC	4	1	0	5	6
	MTMD17F162	Machine Tool Design		4	1	0		
	MTMD17F163	Nanotechnology		4	1	0		
Total Credits for the First Semester							**30**	**36**
SECOND SEMESTER								
1	MTMD17F210	Experimental Stress Analysis	HC	4	1	0	5	6
2	MTMD17F220	Theory of Plasticity	HC	4	1	0	5	6
3	MTMD17F230	Advanced Vibration	HC	4	1	0	5	6
4	MTMD17F241	Finite Element Analysis	SC	4	1	0	5	6
	MTMD17F242	Advanced Materials		4	1	0		
	MTMD17F243	Advanced Machine Design		4	1	0		
5	MTMD17F251	Mechanics of Composite Materials	SC	4	1	0	5	6
	MTMD17F252	Robotics		4	1	0		
	MTMD17F253	Plates and Shells		4	1	0		
6	MTMD17F261	Fracture Mechanics	SC	4	1	0	5	6
	MTMD17F262	Mechatronics & Product Design		4	1	0		
	MTMD17F263	Computational Fluid Dynamics		4	1	0		
Total Credits for the Second Semester							**30**	**36**

Sl. No	Course Code	Title of the course	Types of course (HC/SC)	Credit Pattern			Credit Value	Total Hours
THIRD SEMESTER								
1	MTMD17F311	Automobile System Design	SC	4	1	0	5	6
	MTMD17F312	Advanced Manufacturing Process Simulation		4	1	0		
	MTMD17F313	Design optimization		4	1	0		
2	MTMD17F320	Open Elective	OE	4	1	0	5	6
3	MTMD17F330	Project Phase 1	HC	0	0	10	10	20
		Total Credits for the Third Semester					**20**	32

FOURTH SEMESTER								
1	MTMD17F410	Dissertation	HC	0	0	16	16	
		Total Credits for the Fourth Semester					**16**	
		Total Credits of all Four Semesters					**96**	

Note: 1) Soft Core (SC): Student shall opt for one SC course of his/her choice from the groups framed

2) Open Elective (OE): These are thecourses that are offered for the students of other Schools. The students of the School of Mechanical Engineering have to **choose ONE Open Elective offered by other schools**.

Modern Automotive System(MTMD17F311) is the open elective course which is being offered by School of Mechanical Engineering to the students of other schools.

Guide lines for Project Work:

Project work: Phase-1comprises of literature survey, review paper writing, and problem formulation, identification of tools and techniques, and methodology for the project. Phase – 2, in4th semester should have a visible outcome in the form of publication in a reputed International Conference/Journal or copyright or patent filing.

Detailed Syllabus

FIRST SEMESTER

Course Code	Course Title	Type of	L	T	P	Credit	Total
MTMD17F110	**COMPUTATIONAL METHODS**	HC	4	1	0	5	6

Prerequisites: Engg. Mathematics-I, II, III & IV.

Course Objectives:

1. To enhance the knowledge of numerical methods, optimization, partial differential equations, hyperbola and curve fitting.
2. These concepts occur frequently in their subjects like finite element method and other design application oriented subjects.

Course Outcomes

After the completion of the course the student will be able to:

1. Model simple mathematical models of physical application.
2. Determine and optimize engineering problems in Science and engineering.
3. Differentiate and integrate a function for a given set of tabulated data, for engineering application.
4. Analyze Curve fitting methods for given applications.

Course Contents

UNIT 1

Introduction to numerical methods applied to engineering problems: Examples, solving sets of equations, Matrix notation, Determinants and inversion, Iterative methods, Relaxation methods, system of non-linear equations, computer programs

Numerical integration: Newton-Cotes integration formulas, Simpson's rules, Gaussian quadrature. Adaptive integration. **12hours**

UNIT 2

Optimization: One dimensional unconstrained optimization, multidimensional unconstrained Optimization –direct methods and gradient search methods, constrained optimization Boundary value problems and characteristic value problems: Shooting method – Solution through a set of equations – Derivative boundary conditions – Rayleigh – Ritz method – Characteristic value problems.

12Hours

UNIT 3

Numerical solutions of partial differential equations: Laplace's equations, Representations as a difference equation, Iterative methods for Laplace's equations, Poisson equation, Examples, Derivative boundary conditions , Irregular and non-rectangular grids , Matrix patterns, Sparseness , ADI method , Parabolic partial differential equations: Explicit method, Crank-Nickelson method, Derivative boundary condition, Stability and convergence criteria.

12Hours

UNIT 4

Hyperbolic partial differential equations: Solving wave equation by finite differences stability of numerical method, Method of characteristics-wave equation in two space dimensions-computer programs.

Curve fitting and approximation of functions: Least square approximation fitting of nonlinear curves by least squares, regression analysis, multiple linear regression, nonlinear regression - computer programs.

12Hours

Text Books:

1.StevenC.Chapra, Raymond P.Canale**"Numerical Methods for Engineers"** Tata Mc-Graw Hill.

2. Curtis F.Gerald, partick.O.Wheatly, "**Applied numerical analysis"** Addison-wesley,1989.

3. Douglas J..Faires,Riched Burden "**Numerical methods"** Brooks/cole publishing company,1998.

References:

1.Ward Cheney & David Kincaid "**Numerical mathematics and computing**" Brooks / Cole publishing company 1999, fourth edition.

2.RileyK.F.M.P.Hobson&Bence S.J, "**Mathematical methods for physics and engineering**" Cambridge university press, 1999.

Course Code	Course Title	Type of	L	T	P	Credit	Total hr.
MTMD17F120	**DESIGN OF MECHANISMS**	**HC**	**4**	**1**	**0**	**5**	**6**

Prerequisites: Strength of Materials, Theory of Machine, Mechanical Vibration, Kinematics of Machines, Dynamics of Machines.

Course Objective:

1. It aims at finding out degrees of freedom for any given mechanism
2. Help to provide the designer concept to control the position of any mechanism at a particular instant of time.
3. It helps in solving the mechanism both analytically and graphically
4. Teach the Freudenstein's equation and to gives an idea about the manipulator and its dynamics

Course Outcome

After successful completion of the course the student shall be able to

1. Explain the concept of inversion, degrees of freedom, velocity and acceleration for any given mechanism.
2. Generate the motion for a particular expression and find out the different points traced by a mechanism.
3. Solve the mechanism problems both analytically and graphically by using different methods like number analysis, dimensional analysis etc.
4. Understand and classify dynamics behavior of manipulators.

Course Contents

UNIT 1

Mobility analysis,Degree of freedom (DOF), Mixed mobility, Total, partial and fractional DOF. Closed and open chain systems, Structural analysis and synthesis of mechanisms. Simulations of mechanisms using software.

12Hours

UNIT 2

Alternative design solutions: Coding, evaluation and selection of optimum mechanism, Type synthesis, number synthesis and design of mechanisms.

12Hours

UNIT3

Indexes of merit, graphical, algebraic and optimization techniques: Matrix methods of design and analysis, Design of function, Path and motion generators, Structural and mechanical error.

12Hours

UNIT4

Manipulators – Classification, actuation and transmission systems, coordinate transformation – DH notations, inverse and forward kinematics, Manipulator dynamics from Lagrangian and Newtonian point of view. Simulations of mechanisms using software.

12Hours

TEXT BOOKS:

1. George N Sandor and Arthur G Erdman, Mechanism Design, VOL – 1, PHI, 1988.

2. George N Sandor and Arthur G Erdman, Mechanism Design, VOL – 2, PHI, 1988.

3. Mechanisms & Machines (Analysis & Synthesis) by Arthur G Erdman.

REFERENCES:

1.Klafter R.D., Cmielewski T.A. and Negin M,**"Robot Engineering An Integrated Approach",** Prentice Hall of India, New Delhi,1994.

2. Deb S.R.**"Robotics Technology and Flexible Automation",** Tata McGraw Hill Publishing Co., Ltd., 1994.

Course Code	Course Title	Type of	L	T	P	Credit	Total
MTMD17F130	**THEORY OF ELASTICITY**	**HC**	**4**	**1**	**0**	**5**	**6**

Prerequisites: Engg. Mathematics, Material Science & Metallurgy, Strength of Materials.

Course objectives: Students will

1. To understand stress and strain analysis acting at a point.
2. To computetwo dimensional problems in Cartesian and polar coordinates.
3. To determinestresses in an infinite plate and torsion of bars.
4. To evaluate thethermal stresses for different members.

Course Outcome:

1. To be able to execute the stress state and stresses analysis
2. To be able to solve a problem of strain analysis
3. To be able to use the numerical methods for the problem of the theory of elasticity in practice.
4. To be able to use theory for solution of practice problem of stress and strain analysis Final examination.

Course Contents

UNIT 1

Definition And Notation: Stress, Stress at a Point, Equilibrium Equations, Principal Stresses, Mohr's Diagram, Maximum Shear Stress, Boundary Conditions.
Strain ata Point: Compatibility Equations, Principal Strains, Generalised Hooke's law, Methods of Solution of Elasticity Problems – Plane Stress- Plane Strain Problems.

12Hours

UNIT 2

Two Dimensional Problems: Cartesian co-ordinates, Airy's stress functions, Investigation of Airy's Stress function for simple beam problems, Bending of a narrow cantilever beam of rectangular cross section underedge load, method of Fourier analysis, pin ended beam under uniform pressure.

General Equations in Cylindrical Co-Ordinates: Thick cylinder under uniform internal and / or external pressure, shrink and force fit, stress concentration.**12Hours**

UNIT 3

Stresses in an Infinite Plate (with a circular hole) subjected to uniaxial and biaxial loads, stress concentration, stresses in rotating discs and cylinders.
Torsion of Circular, Elliptical and Triangular Bars: membrane analogy, torsion of thin open sections and thin tubes. **12Hours**

UNIT 4

Thermal Stresses: 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 principle.

12Hours

TEXT BOOKS:

1.Advanced Mechanics of solids, L. S. Srinath, Tata Mc. Graw Hill, 2003
2.Theory of Elasticity, S. P. Timoshenko and J. N Gordier, Mc.Graw Hill International, 3rd edition, 1972

REFERENCES BOOKS:

1.Theory of Elasticity, Dr. Sadhu Singh, Khanna Publications, 1988
2. **Elasticity, Theory, Applications &Numericals,** Martin H Sadd, Elsevier. 2005
3. **Applied Elasticity,** Seetharamu&Govindaraju, Interline Publishing
4. **Applied Elasticity,** C.T. WANG Sc. D. McGraw Hill Book Co.1953

Course Code	Course Title	Type of	L	T	P	Credit	Total
MTMD17F141	**GEAR DESIGN**	**SC**	**4**	**1**	**0**	**5**	**6**

Prerequisites: Strength of Materials, Machine Design-I & II, Theory of Machine

Course Objectives: Students will be able to:

1. Describe the "Law of Gearing," conjugate action and specifically, involute profiles
2. Review the various definitions and terms used in gearing
3. Identify the function and operation of all gear arrangements
4. Appraise preliminary design considerations and the gear system design process
5. Explain practical gear measurement and inspection techniques, tools and equipment
6. Recognize "Best Practices" in regards to gear system design

Course Outcomes:

1. Mechanical power transmission system design, development, durability assessment and application
2. Application and development of geared systems technologies
3. Management of transmission designers and manufacturers
4. Supply of components and sub-systems to mechanical power transmission system manufacturers

Course Contents

UNIT 1

Introduction: Principles of gear tooth action, Generation of Cycloid and Involute gears, Involutometry, gear manufacturing processes and inspection, gear tooth failure modes, stresses, selection of right kind of gears.
Spur Gears: Tooth loads, Principles of Geometry, Design considerations and methodology, Complete design of spur gear teeth considering Lewis beam strength, Buckingham's dynamic load and wear load, Design of gear shaft and bearings.

12Hours

UNIT 2

Helical Gears: Tooth loads, Principles of Geometry, Design considerations and methodology, Complete design of helical gear teeth considering Lewis beam strength, Buckingham's dynamic load and wear load, Design of gear shaft and bearings.
Bevel Gears: Tooth loads, Principles of Geometry, Design considerations and methodology, Complete design of bevel gear teeth considering Lewis beam strength, Buckingham's dynamic load and wear load, Design of gear shaft and bearings.

12Hours

UNIT 3

Worm Gears: Tooth loads, Principles of Geometry, Design considerations and methodology, Complete design of worm gear teeth considering Lewis beam strength, Buckingham's dynamic load and wear load, Heat dissipation considerations. Design of gear shaft and bearings.
Gear failures: Analysis of gear tooth failures, Nomenclature of gear tooth wear and failure, tooth breakage, pitting, scoring, wear, overloading, gear-casting problems, lubrication failures . **12Hours**

UNIT 4

Gear trains: Simple, compound and epicyclic gear trains, Ray diagrams, Design of a gear box of an automobile, Design of gear trains from the propeller shafts of airplanes for auxiliary systems.
Optimal Gear design: Optimization of gear design parameters, Weight minimization, Constraints in gear train design-space, interference, strength, dynamic considerations, rigidity etc. Compact design of gear trains, multi objective optimization of gear trains. Application of Traditional and non-traditional optimization techniques.

12Hours

Text Books:

1. Maleev and Hartman, Machine Design, C.B.S. Publishers, India.
2. Henry E.Merrit,Gear engineering ,Wheeler publishing,Allahabad,1992.
3. Practical Gear design by Darle W. Dudley, McGraw-Hill book company.

References:

1. Earle Buckingham, Analytical mechanics of gears, Dover publications, New York, 1949.
2. G.M.Maitha, Hand book of gear design, TATAMc.Graw Hill publishing company Ltd.,New Delhi,1994.

Course Code	Course Title	Type	L	T	P	Credit	Total

MTMD17F142	DESIGN OF EXPERIMENTS	SC	4	1	0	5	6

Prerequisites: Engineering Mathematics, Design of machine elements.

Preamble:

Quality of Product is very important these days. Design of experiment will enable the researcher to identify various controllable & uncontrollable factors & conduct experimentation to produce good quality products.

Course objectives:

1. To make students to understand & plan an experimentation & select an appropriate experimental
2. design.
3. To enable students to identify various control factors & their levels for designing experimentation.
4. To understand & identify the uncantidable variables their existence in the process of experimentation.
5. To educate the students quality loss function and its impact on the society.

Course outcomes

After successful completion of the course the student shall be able to

1. Identify the various controllable & uncontrollable factors on the design of experiments.
2. Experiment under various situation to solve Classical Experiments: Factorial Experiments: Terminology: factors, levels, interactions, treatment combination, randomization.
3. Apply the Experiment Design Using Taguchi's Orthogonal Arrays.
4. Describe the Signal To Noise Ratio, Parameter And Tolerance Design.

Course Contents

UNIT 1

Introduction: Strategy of Experimentation, Typical applications of Experimental design, Basic Principles, Guidelines for Designing Experiments.

Basic Statistical Concepts: Concepts of random variable, probability, density function cumulative distribution function. Sample and population, Measure of Central tendency; Mean median and mode, Measures of Variability, Concept of confidence level. Statistical Distributions: Normal, Log Normal & Weibull distributions. Hypothesis testing, Probability plots, choice of sample size. Illustration through Numerical examples. **12Hour**

UNIT - 2

Experimental Design: Classical Experiments: Factorial Experiments: Terminology: factors, levels, interactions, treatment combination, randomization, Two-level experimental designs for two factors and three factors. Three-level experimental designs for two factors and three factors, Factor effects, Factor interactions, Fractional factorial design, Saturated Designs, Central composite designs. Illustration through Numerical examples. **12Hours**

Analysis And Interpretation Methods: Measures of variability, Ranking method, Column effect method & Plotting method, Analysis of variance (ANOVA) in Factorial Experiments: YATE's algorithm for ANOVA,Regression analysis, Mathematical models from experimental data. Illustration through Numerical examples. **12Hours**

UNIT - 3

Quality By Experimental Design: Quality, Western and Taguchi's quality philosophy, elements of cost, Noise factors causes of variation. Quadratic loss function & variations of quadratic loss function. Robust Design: Steps in Robust Design: Parameter design and Tolerance Design. Reliability Improvement through experiments, Illustration through Numerical examples.

Experiment Design Using Taguchi's Orthogonal Arrays: Types of Orthogonal Arrays, selection of standard orthogonal arrays, Linear graphsand Interaction assignment, Dummy level Technique, Compound factor method, Modification of linear graphs.Illustration through Numerical examples.

12Hours

UNIT - 4

Signal To Noise Ratio: Evaluation of sensitivity to noise. Signal to Noise ratios for static problems: Smaller-the-better type, Nominal-the –better-type, Larger-the-better type. Signal to Noise ratios for Dynamic problems. Illustration through Numerical examples.

Parameter and Tolerance Design: Parameter and tolerance design concepts, Taguchi's inner and outer arrays, parameter design strategy, tolerance design strategy. Illustration through Numerical.**12Hours**

TEXT BOOKS:

1. **Design and Analysis of Experiments,** Douglas C. Montgomery, 5th Edition Wiley India Pvt. Ltd. 2007
2. **Quality Engineering using Robust Design,** Madhav S. Phadke, Prentice Hall PTR, Englewood Cliffs, New Jersy 07632, 1989.

REFERENCE BOOK:

1. **Quality by Experimental Design,** Thomas B. Barker, MarcelDekker, Inc ASQC Quality Press.1985.
2. **Experiments Planning, analysis, and parameter Design optimization,** C.F. Jeff Wu Michael Hamada, John Wiley Editions.2002.
3. **Reliability Improvement by Experiments,** W.L. Condra, MarcelDekker, Inc ASQC Quality Press.1985.
4. **Taguchi Techniques for Quality Engineering,** Phillip J. Ross, 2ndEdn. McGraw Hill International Editions, 1996.

Course Code	Course Title	Type	L	T	P	Credit	Total

MTMD17F143	**FAILURE ANALYSIS AND DESIGN**	**SC**	**4**	**1**	**0**	**5**	**6**

Prerequisites: Engg. Mathematics, Strength of Materials, Theory of Elasticity, Theory of Plasticity, Machine Design.

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. Students will be able to:

At the end of the course, the student will 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 Contents

UNIT 1

Role of Failure Prevention Analysis in Mechanical Design: Introduction, Definition of design, challenge and some design objectives.

Modes of Mechanical Failure: Definition of failure mode, failure modes observed in practice, a glossary of mechanical failure modes

Introduction to Fracture Mechanics: An introduction to linear elastic fracture mechanics, use of fracture mechanics design, elastic-plastic fracture mechanics.**12Hours**

UNIT 2

High-Cycle Fatigue: Introduction, historical remarks, nature of fatigue, fatigue loading, laboratory fatigue testing, the S-N-P curves, factors that affect S-N-P curves, using the factors in design, the influence of nonzero mean stress, multi axial fatigue stresses, using multi axial fatigue failure theories.

12Hours

UNIT 3

Cumulative Damage, Life Prediction and Fracture Control: Introduction, the Linear damage theory, cumulative damage theories, life prediction based on local stress-strain and fracture mechanics concepts, service loading simulation and full scale fatigue testing, damage

tolerance and fracture control.

12Hours

UNIT 4

Low-Cycle Fatigue: Introduction, the strain cycling concept, the strain life curve and low-cycle fatigue relationships, the influence of nonzero mean strain and nonzero mean stress, cumulative damage rule in low-cycle fatigue.

Creep, Stress Rupture and Fatigue: Introduction, prediction of long-term creep behaviour, theories for predicting creep behaviour, creep under uni axial state of stress and multi axial state of stress, cumulative creep concept, combined creep and fatigue.

12Hours

Text book:

1. **Failure of Materials in Mechanical Design: Analysis, Prediction, Prevention**, J. A. Collins, John Wiley & Sons, Inc.

References:

1. Fatigue of Materials, S. Suresh, Cambridge University Press.

2. Fracture Mechanics: Fundamentals and Applications, T. L. Anderson, CRC Press.

Course Code	Course Title	Type of	L	T	P	Credit	Total
MTMD17F151	**ROTOR DYNAMICS**	**SC**	**4**	**1**	**0**	**5**	**6**

Prerequisites: Engg. Mathematics, Turbo Machines, Tribology, FEM, Mechanical Vibrations.

Course Objective:

1. To enable the students to understand Basic theory of fluid film lubrication, Derivation of generalized Reynolds equations, Boundary conditions,
2. 2. Provide systematic basic knowledge for Rayleigh's method, Stodola's method. Rotor Bearing System: Instability of rotors due to the effect of hydrodynamic oil layer in the bearings,
3. To enable the students to understand General turborotor system, development of element transfer matrices, the matrix differential equation
4. Formulate the General turborotor system, generalized forces and co-ordinates system assembly element matrices.

Course Outcome:

After completion of the course the student will be able to

1. Demonstrate the fundamentals of Fluid Film Lubrication& Flexible Shafts.
2. Formulate the Critical Speed: Dunkerley's method.
3. Determine the Turbo rotor System Stability by Transfer Matrix Formulation.
4. Derive the Turbo rotor System Stability by Finite Element Formulation.

Course Content:

UNIT 1

Fluid Film Lubrication: Basic theory of fluid film lubrication, Derivation of generalized Reynolds equations, Boundary conditions, Fluid film stiffness and Damping coefficients, Stability and dynamic response for hydrodynamic journal bearing, Two lobe journal bearings.
Stability of Flexible Shafts: Introduction, equation of motion of a flexible shaft with rigid support, Radial elastic friction forces, Rotary friction, friction Independent of velocity, friction dependent on frequency, Different shaft stiffness Constant, gyroscopic effects, Nonlinear problems of large deformation applied forces, instability of rotors in magnetic field. **12 Hours**

UNIT 2

Critical Speed: Dunkerley's method, Rayleigh's method, Stodola's method. Rotor Bearing System: Instability of rotors due to the effect of hydrodynamic oil layer in the bearings, support flexibility, Simple model with one concentrated mass at the center.

12Hours

UNIT 3

Turborotor System Stability by Transfer Matrix Formulation: General turborotor system, development of element transfer matrices, the matrix differential equation, effect of shear and rotary inertia, the elastic rotors supported in bearings, numerical solutions.

12Hours

UNIT 4

Turborotor System Stability by Finite Element Formulation: General turborotor system, generalized forces and co-ordinates system assembly element matrices, Consistent mass matrix formulation, Lumped mass model, linearised model for journal bearings, System dynamic equations Fix stability analysis non-dimensional stability analysis, unbalance response and Transient analysis.
Blade Vibration: Centrifugal effect, Transfer matrix and Finite element, approaches.

12Hours

TEXT BOOK

1**. Cameron,** "Principles of Lubrication", Longman Publishing Group, 1986
2. **Bolotin**, "Nonconservative problems of the Theory of elastic stability", Macmillan, 1963

REFERENCE BOOKS:

1**. Peztel, Lockie ,** "Matrix Methods in Elasto Mechanics", McGraw-Hill, 1963.
2. **Timosenko** , "Vibration Problems in Engineering", Oxford City Press, 2011
3. **Zienkiewicz**, "The finite element method in engineering science", McGraw-Hill, 1971

Course Code	Course Title	Type of	L	T	P	Credit	Total

MTMD17F152	**DESIGN FOR MANUFACTURING**	**SC**	**4**	**1**	**0**	**5**	**6**

Prerequisites: Strength of Materials, Manufacturing Technology, Machine Design.

Course Objective:

1. To enable the students to understand General design principles for manufacturability, strength and mechanical factors, mechanisms selection.
2. Provide systematic basic knowledge for Working principle, Material, Manufacture, Design Possible solutions, Materials choice,
3. To enable the students to understand Design features to facilitate machining - drills - milling cutters, keyways, Doweling procedures
4. Formulate the Identification of uneconomical design, Design for economy, Design for clamp ability, Design for accessibility, modifying the design.

Course Outcome:

After completion of the course the student will be able to

1. Demonstrate the fundamentals of evaluation method, Process capability, Feature tolerances, Geometric tolerances, Assembly limits, Datum features, Tolerance stacks.
2. Formulate Factors Influencing Form Design: Working principle, Material, Manufacture, Design Possible solutions.
3. Determine the Component Design in Machining &Casting Considerations.
4. Design for Manufacture and Case Studies, Identification of uneconomical design, Design for economy.

Course Contents

UNIT 1

Introduction: General design principles for manufacturability, strength and mechanical factors, mechanisms selection, evaluation method, Process capability,Featuretolerances,Geometric tolerances ,Assembly limits, Datum features ,Tolerance stacks.

12Hours

UNIT 2

Factors Influencing Form Design: Working principle, Material, Manufacture, Design Possible solutions, Materials choice, Influence of materials on from design from design of welded members, forgings and castings.

12Hours

UNIT 3

Component Design Machining Consideration: Design features to facilitate machining - drills - milling cutters, keyways,Doweling procedures, counter sunk screws ,Reduction of machined area - simplification by separation, simplification by amalgamation ,Design for machineability.

Component Design Casting Considerations: Redesign of castings based on parting line considerations,Minimizing core requirements, machined holes, redesign of cast members to obviate cores.

12Hours

UNIT 4

Design for Manufacture and Case Studies: Identification of uneconomical design, Design for economy, Design for clamp ability ,Design for accessibility,Modifying the design,Design for assembly ,Group technology ,Computer Applications for DFMA.

12Hours

TEXT BOOK

Harry Peck, **"Design for Manufacture"**, Pittman Publication, 1983.

REFERENCES

1. Robert Matousek, "Engineering Design - A systematic approach", Blackie & sons Ltd.
2. James G. Bralla, "Hand Book of Product Design for Manufacturing", McGraw Hill Co.
3. Swift K.G, "Knowledge based design for manufacture, Kogan Page Ltd., 1987.

Course Code	Course Title	Type	L	T	P	Credit	Total
MTMD17F153	**COMPUTER GRAPHICS**	**SC**	**4**	**1**	**0**	**5**	**6**

Prerequisites: Engg. Mathematics, C-Programming.

Course Objective:

1. To make to students to understand andrecognize how a visual image
2. To make students to solve visual communication problems
3. To enable the students to understand visual hierarchy using images and text

Course Outcome:

After completion of the course the student will be able to

1. Recognize how a visual image can be an effective means of communication
2. Acquire and develop the skills needed to creatively solve visual communication problems.
3. Understand, develop and employ visual hierarchy using images and text
4. Explain visual realism.

Course Content

Unit 1

Transformations : Representation of points, Transformations: Rotation, Reflection, Scaling, Shearing, Combined Transformations, Translations and Homogeneous Coordinates, A geometric interpretation of homogeneous coordinates, Over all scaling, Points at infinity,

Rotation about an arbitrary point, Reflection through an arbitrary line, Rotation about an axis parallel to coordinate axis, Rotation about an arbitrary axis in space, Reflection through an arbitrary plane. **12 Hours**

Unit 2

Types and Mathematical Representation of Curves: Curve representation, Explicit, Implicit and parametric representation. Nonparametric and parametric representation of Lines,Circles,Ellipse, Parabola, Hyperbola, Conics. Parametric representation of synthetic curve, Hermite cubic splines, Bezier curves: Blending function, Properties, generation, B-spline curvesCox-deBoor recursive formula, Properties, Open uniform basis functions, Non-uniform basis functions, Periodic B-spline curve. Types and Mathematical Representation of Surfaces Surface entities and parametric representation- Plane, Ruled, surface of revolution, Offset surface, Coons patch, Bezier surface, B-spline surface.

12 Hours

Unit 3

Types and Mathematical Representation of Solids Solid entities: Block, Cylinder, Cone, Sphere, Wedge, Torus, Solid representation, Fundamentals of solid modeling, Set theory, Regularized set operations, Set membership classification, Half spaces, Basic elements, Building operations, Boundary representation and Constructive solid geometry, Basic elements, Building operations. Scan Conversion and Clipping: Representation of points, lines, Drawing Algorithms: DDA algorithm, Bresenham's integer line algorithm, Bresenham's circle algorithm, Polygon filling algorithms: Scan conversion, Seed filling, Scan line algorithm. Viewing transformation, Clipping - Points, lines, Text, Polygon, Cohen-Sutherland line clipping, Sutherland-Hodgmen algorithm.

12 Hours

Unit 4

Visual Realism: Introduction, Hidden line removal, Visibility of object views, Visibility techniques: Minimax test, Containment test, Surface test, Silhouttes, Homogeneity test, Sorting, Coherence, Hidden surface removal- Z-buffer algorithm, Warnock's algorithm, Hidden solid removal - ray tracing algorithm, Shading, Shading models, Diffuse reflection, Specular reflection, Ambient light, Shading of surfaces: Constant shading, Gourand shading, Phong shading, Shading enhancements, Shading Solids, Ray tracing for CSG, Z-buffer algorithm for B-rep and CSG . **12 Hours**

TEXT BOOKS:

1. IbrahamZeid, CAD/CAM-Theory and Practice-McGraw Hill, 2006.
2. David Rogers & Alan Adams, Mathematical Elements for Computer Graphics-Tata McGraw Hill, 2002.

REFERENCE BOOKS:

1.Xiang Z, Plastock, R. A, Computer Graphics- Schaum's Outline, McGraw Hill, 2007.
2. Foley, van Dam, Feiner and Hughes, Computer Graphics- Principles and Practice-Addison Wesley, 1996.
3. Sinha A N, Udai A D, Computer Graphics- Tata McGraw Hill, 2008.

Course Code	Course Title	Type	L	T	P	Credit	Total
MTMD17F161	TRIBOLOGY	SC	4	1	0	5	6

Prerequisites: Engg. Mathematics, Machine Design, Elements of Mechanical Engineering.

Course Objective:

1. Recognize the properties of lubrication, Regimes of Lubrication
2. Identify the Hydrodynamic Lubrication
3. Identify types of Slide Bearing & Journal Bearings
4. Knowledge about Hydrostatic Bearings, EHL, Porous & Gas Bearings

Course Outcome:

After completion of the course the student will be able to

1. Identify the fundamentals of Effect of Pressure and Temperature on Viscosity, types of Viscometers. Friction.
2. Detect the pressure distribution of hydrodynamic bearings analytically and experimentally.
3. Investigate the life-cycle of a journal nearing and Idealized Slide Bearing
4. Design the Hydrostatic Bearings, EHL, Porous & Gas Bearings

Course Contents

UNIT 1

Introduction to Tribology: Introduction, properties of lubrication, Regimes of Lubrication, Classification of Contacts, Lubrication Theories. Newton's Law of Viscous Forces, Effect of Pressure and Temperature on Viscosity, types of Viscometers.Friction, Wear, Wear Characteristics. **12Hours**

UNIT 2

Hydrodynamic Lubrication: Flow through Stationary Parallel Plates. Hagen's Poiseuille's Theory. Numerical Problems. Concept of Lightly Loaded Bearings, Petroff's Equation, Numerical Problems.

Hydrodynamic Bearings: Pressure Development Mechanism. Converging and Diverging Films and Pressure induced Flow. Reynolds's 2-D Equation with assumptions.

12Hours

UNIT3

Idealized Slide Bearing: Introduction, Idealized Slide Bearing with Fixed Shoe and Pivoted Shoes. Expression for Load Carrying Capacity. Location of Center of Pressure, Numerical Problems .

Journal Bearings: Introduction to Idealized Full Journal Bearings. Load Carrying Capacity of Idealized Full Journal Bearings, Sommerfeld Number and its Significance. Comparison between Lightly Loaded and Heavily Loaded Bearings, Numerical Problems.

12Hours

UNIT4

Hydrostatic Bearings: Types of Hydrostatic Lubrication Systems Expression for Discharge, Load Carrying Capacity, Flow Rate, Condition For Minimum Power Loss. Torque Calculations. Numerical Problems.

EHL Contacts: Introduction, 'Ehl' Constant, Grubin type solution.

Porous & Gas Bearings: Introduction, Working Principle, advantages and disadvantages.

Magnetic Bearings: Introduction, Active Magnetic Bearings, Working Principle, advantages and disadvantages.

12Hours

TEXT BOOKS:

1.**Radixmovsky**, "Lubrication of Bearings - Theoretical principles and design" The Oxford Press Company, 2000.

2.Mujamdar.B.C "Introduction to Tribology of Bearing", Wheeler Publishing,New Delhi2001.

3. Susheel Kumar Srivasthava "Tribology in industry" S.Chand and Co.

REFERENCE BOOKS:

1. **Dudley D.Fulier**"Theory and practice of Lubrication for Engineers**"**, New York CO.1998

2. **Moore"**Principles and applications of Tribology**"**Pergamon press.

3.Gerhandschwetizer, Hannes Bleuler&AlfonsTraxler, "Active Magnetic bearings", Authors working group, www.mcgs.ch., 2003.

Course Code	Course Title	Type of	L	T	P	Credit	Total
MTMD17F162	**MACHINE TOOL DESIGN**	**SC**	**4**	**1**	**0**	**5**	**6**

Prerequisites: Metrology &Measurements,Strength of Materials, Machine Design, Theory of Machines

Course objective:

1. To impart the fundamental notations of the machine tools including the different types, construction, applications and their technological capabilities.
2. To provide exposure to the systematic methods for solving the problems of designing machine tools and their components by exploring the various design aspects of machine tools elements like transmissions, structures, materials, kinematics, dynamics and construction of machine tools, etc.

Course Outcomes:

After completion of the course the student will be able to:

1. Analyze constructions and kinematic schemata of different types of machine tools.
2. Construct ray diagrams and speed spectrum diagrams for speed and feed box.
3. Develop the conceptual design, manufacturing framework and systematic analysis of design problems on the machine tools.
4. Apply the design procedures on different types of machine tool and/or machine tool components.

Course Contents

UNIT 1

Machine Tool Drive: Working and auxiliary motion in machine, Machine tool drives, Hydraulic transmission, Mechanical transmission, General requirements of machine tool design, Layout of machine tools.

Regulation of Speed and Feed Rates: Aim of speed feed regulation, Stepped regulation of speed, Design of speed box, Design of feed box, Special cases of gear box design, Set stopped regulation of speed and feed rates.

12Hours

UNIT 2

Design of Machine Tool Structure: Fundamentals of machine tool structures and their requirements, Design criteria of machine tool structure, Static and dynamic stiffness, Design of beds and columns, Design of housing models, Techniques in design of machine tool structure. **12Hours**

UNIT 3

Design of Guide-ways and power Screws: Function and type of guide-ways, Design of slide-ways, protecting devices for slide-ways, Design of power screws. Design of Spindles and Spindle Supports: Materials for spindles, Design of spindles, Antifriction bearings, Sliding bearings. **12Hours**

UNIT 4

Dynamics of Machines Tools: General procedure of assessing dynamic stability of EES, Cutting processing, closed loop system, Dynamic characteristics of cutting process, Stability analysis. **12Hours**

TEXT BOOKS:

1. Machine Tool Designby N.K. Mehta Tata McGraw Hill.

2. Machine Tool design Handbook - CMTI Bangalore.

Course Code	Course Title	Type of	L	T	P	Credit	Total
MTMD17F163	NANO TECHNOLOGY	SC	4	1	0	5	6

Prerequisites: Materials Science, Applied Physics

Objectives:

1. To enable the students understand the basic concepts of Nanotechnology
2. To enhance the knowledge of students in nanomaterials
3. To familiarize the students with the properties of nanomaterials and their applications
4. To expose the students MEMS / NEMS devices and their applications

Expected Outcome:

After completion of the course the student will be able to:

1. Student will be able to use Nanomaterials for various industrial applications
2. Design MEMS / NEMS devices for various applications.
3. Demonstrate the knowledge of devices used in MEMS/NEMS

Course Contents

Unit 1

Introduction to Nanoscience&Technology: Single crystal, polycrystal and a nanocrystal-Nano in nature- Significance of nanostructures-- Present and future applications of nanomaterials

Classification of nanomaterials - magic numbers-Electronic and structural magic numbers - bulk to nanotransition- Size dependent property changes- Factors leading to changes-Surface to volume ratio and quantum confinement -stabilization of nanoparticles.

12Hours

Unit 2

Synthesis, characterization of nanomaterials and mechanical properties: Bottom-up and top down approaches- Inert gas condensation- Ball milling and Sol gel lithographic techniques- Particle size determination- XRD- laser diffraction- SEM,TEM, Raman ,Infrared spectroscopies , AFM and contact angle measurement and porosimeter –phase transitions in nano systems- Inverse-Hall-Petchbehaviour–mechanical properties of nanomaterials.

12Hours

Unit 3

Applications of Nanomaterials in automobiles, aerospace, energy and biomedical areas: Metallic nanoparticles, Cu, Ag,Au,Pd,Rh ,Modulus and hardness, melting point depression , catalytic, antifungal and anti bacterial properties, chemical sensors ,CeO_2- fuel efficiency – magnetic nanoparticles, Metallic nanoparticles, Cu, Ag,Au,Pd,Rh ,Modulus and hardness, melting point depression , catalytic, antifungal and anti bacterial properties, chemical sensors ,CeO_2- fuel efficiency magnetic nanoparticles.

12Hours

Unit 4

Nanomachines and Nanodevices: Microelecrtoromechanical systems-(MEMS)–Nanoelectromechanical systems (NEMS), Fabrication-nanodevices and nanomachines , molecular and supramolecular switches . Nano tribology.

12Hours

TEXT BOOKS

1. **Charles P. Poole, Frank J. Owens,** (2000), Introduction to Nanotechnology, John Wiley & Sons.
2. **C.N.R.Rao, P.J.Thomas and U.Kulkarni**, Nanomaterials:Synthesis, properties and applications Springer-Verlag (2007)

REFERENCES

1. **Nanocrystallinematerials,Glieter,** Progress in Materials Science Vol. 33, pp. 223-315, 1989
2. Mechanical alloying and milling, **C. Suryanarayana,** Progress in Materials Science 46 (2001) 1,184

SECOND SEMESTER

Course Code	Course Title	Type	L	T	P	Credit	Total
MTMD17F210	EXPERIMENTAL STRESS ANALYSIS	HC	4	1	0	5	6

Prerequisites: Engg. Mathematics, Strength of Materials, Theory of Elasticity, Metrology & Measurements.

Course Objective:

1. To understand the relation between the mechanics theory and experimental stress analysis.
2. To establish the fundamental concepts and newly experimental techniques.
3. To be able to use the experimental techniques on the practical problems.
4. To be able to make a fine presentation related to the experimental paper.

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

1. Describe the Sensitivity & the construction of strain gauges.
2. Elucidate the isoclinics& Fringe multiplication techniques.
3. Explain the stress separation methods of 3D photoelasticity.
4. Describe the Birefringence coating techniques &Moire's Techniques.

Course Contents

UNIT1

Introduction: Theory of Elasticity, Plane stress and plane strain conditions, Compatibility conditions. Problems using plane stress and plane strain conditions, Three-dimensional stress strain relations.

Strain Measurement Methods: Various types of strain gauges, Electrical Resistance strain gauges, semiconductor strain gauges, strain gauge circuits.

12 Hours

UNIT2

Recording Instruments: Introduction, static recording and data logging, dynamic recording at very low frequencies, dynamic recording at intermediate frequencies, dynamic recording at high frequencies, dynamic recording at very high frequencies, telemetry systems.

Brittle coatings: Introduction, coating stresses, failure theories, brittle coating crack patterns, crack detection, ceramic based brittle coatings, and resin based brittle coatings, test procedures for brittle coatings analysis, calibration procedures, analysis of brittle coating data.

12 Hours

UNIT3

Bi-refringentCoatings: Introduction, Coating stresses and strains, coating sensitivity, coating materials, application of coatings, effects of coating thickness, Fringe-order determinations in coatings, stress separation methods.

Moire Methods: Introduction, mechanism of formation of Moire fringes, the geometrical approach to Moire-Fringe analysis, the displacement field approach to Moire-Fringe analysis, out of plane displacement measurements, out of plane slope measurements, sharpening and multiplication of Moire-Fringes, experimental procedure and techniques.

12 Hours

UNIT4

Photo Elasticity: Photo elasticity – Polariscope – Plane and circularly polarized light, Bright and dark field setups, Photo elastic materials – Isochromatic fringes – Isoclinics

Threedimensional Photo Elasticity : Introduction, locking in model deformation, materials for three-dimensional photo elasticity, machining cementing and slicing three-dimensional models, slicing the model and interpretation of the resulting fringe patterns, effective stresses, the shear difference method in three dimensions, applications of the Frozen-stress method, the scattered light method. **12 Hours**

TEXT BOOKS :

1.Theory of Elasticity by Timoshenko and Goodier Jr.
2.Experimental Stress Analysis by Dally and Riley, Mc Graw-Hill.

REFERENCES:

1. A treatise on **Mathematical theory of Elasticity** by LOVE .A.H

Course Code	Course Title	Type of	L	T	P	Credit	Total
MTMD17F220	THEORY OF PLASTICITY	HC	4	1	0	5	6

Prerequisites: Strength of Materials, Material Science & Metallurgy, Engg. Mathematics(Non-linear), Theory of Elasticity**.**

Course Objective:

1. Provides a basic theory of plasticity for the understanding of the flow curve.
2. Differences between the true stress – true straincurve and the engineering stress – engineeringstrain curves will be highlighted.
3. Finally the understanding of the yielding criteria forductile materials will be made.

Course outcome:

After completion of the course the student will be able to:

1. Solve two and three dimensional problems of cylindrical bodies.
2. Know the stress strain relation for a body subjected to loading within elastic limit.
3. Got the relation for a body subjected to thermal expansion.

Course Contents

UNIT 1

Fundamental of Elasticity: Concept of stress, stress transformation laws, spherical and deviator stress tensors, equilibrium equations, octahedral stresses, concept of strain, deviator and spherical strain tensors, strain transformation laws, octahedral strains, generalized Hooke's law, elastic strain energy, compatibility equations, theories of strength. Problems.
Plastic Deformation of Metals: Crystalline structure in metals, mechanism of plastic deformation, factors affecting plastic deformation, strain hardening, recovery, recrystallization and grain growth, flow figures or luder's cubes.

12 Hours

UNIT 2

Cubical Dilation, True Stress And Strain: Strain tensor, principal strain, plane strain, spherical and deviator strain, octahedral strain and representative strain, problems
Stress Strain Relations: Introduction, types of materials, empirical equations, theories of plastic flow, experimental verification of St.Venant's theory of plastic flow, the concept of plastic potential, the maximum work hypothesis, mechanical work for deforming a plastic substance. **12 Hours**

UNIT 3

Yield Criteria: Introduction, yield or plasticity conditions, Von Mises and Tresca criteria, Geometrical representation, yield surface, yield locus (two dimensional stress space), experimental evidence for yield criteria, energy required to change the shape with basic principle problems
Slip Line Field Theory: Introduction, basic equations for incompressible two dimensional flow, continuity equations, stresses in conditions of plain strain, convention for slip lines, solutions of plastic deformation problem,Geometry of slip line field, Properties of the slip lines, construction of slip line nets **14 Hours**

UNIT 4

Bending of Beams: Analysis for stresses, Nonlinear stress strain curve, shear stress distribution, residual stresses in plastic bending, problems.

Torsion of Bars: Introduction, plastic torsion of a circular bar, elastic perfectly plastic material, elastic work hardening of material, residual stresses and problems.

10Hours

TEXT BOOKS:

1. '**Theory of Plasticity',** Chakraborty 3rd Edition Elsevier.
2. **'Engineering Plasticity',** W. Johnson and P. B. Mellor D Van N.O Strand Co. Ltd 2000

REFERENCE BOOKS:

1. **Basic Engineering Plasticity,** DWA Rees 1st Edition Elsevier.
2. **Theory of Plasticity,** L. S. Srinath TMH,
3. **Theory of Plasticity,** Sadhu Singh, Kanna publisher

Course Code	Course Title	Type	L	T	P	Credit	Total
MTMD17F230	**AdvancedVibrations**	**HC**	**4**	**1**	**0**	**5**	**6**

Prerequisites: Mechanical Vibrations, Strength of Materials, Engg. Mathematics

Course Objectives:

1. To enable the students to understand response to periodic and non-periodic excitations.
2. To teach students about transient Vibration by Laplace transformation formulation.
3. To enable students to solve free vibration of spring - coupled systemsunder 2DoFs
4. To apply modal analysis to forced vibrations using matrix inversionfor MDOF systems.
5. To understand the importance of condition monitoring techniques.
6. To apply SPM and AE techniques in analysing machine failures.

Course Outcomes:

After completion of the course the student will be able to:

1. Apply Duhamel's Integral in solving Impulse response function.
2. Analyse transient vibrations using Laplace transformation formulation.
3. Analyze MDOF systems for Eigen values and Eigen vectors.
4. Apply SPM and AE methods to identify machine failures and Analyze fan bearings and gas compressors.

Course Contents

UNIT 1

Fundamentals of vibration: Review of Single degree system - Response to periodic and non-periodic excitations - Duhamel's Integral – Impulse Response function - Single degree freedom forced vibration with elastically coupled viscous dampers -Transient Vibration - Laplace transformation formulation.

Two degree of freedom systems: Free vibration of spring - coupled systems-Simple problems **12 Hours**

UNIT 2

Multi-degree of freedom system: Normal mode of vibration - Flexibility Matrix and Stiffness matrix - Eigen values and Eigen vectors - orthogonal properties - Modal matrix,Modal Analysis - Forced Vibration by matrix inversion.

Vibration of continuous systems: Vibration of strings-wave equations - vibration of rods - Euler Equation for Beams - Effect of Rotary inertia and shear deformation.

12 Hours

UNIT 3

Condition monitoring methods and Vibration analysis: VariousCondition Monitoring Methods,Economics of Condition Monitoring,Setting up a CM Activity.

Machinery signatures,Vibration severity criteria, Vibration frequency domainand time domain analysis,Shock Pulse Methods fortesting Antifriction bearings,Acoustic emission technique (AET)- Instrumentation, Transducers, Preamplifier and filter, Main amplifier and Signal processing/ Display unit. **12 Hours**

UNIT 4

Condition Monitoring Case Studies & Applications: Failure of fan bearings- History of failures,Analysis of the failures, Solution.High frequency vibration of gas compressor-History of trouble, Analysis of trouble, Solution. Monitoring of cracks in rotors-Turbocompressor misalignment. Detection of faulty electrical components. Turbine shell distortion. Symptoms and Detections. **12Hours**

TEXT BOOKS:

1. **Rao, S.S**, "Mechanical Vibrations", Addison Wesley Longman, 1995.

2.Thomson, W.T. "Theory of Vibration with Applications", CBS Publishers and Distributors, New Delhi, 1990.

3.R. A., Caollacatt Chapman "Mechanical Fault Diagnosis and Condition Monitoring", Chapman and hall 1977.

REFERENCES:

1.Thomson, W.T. "Theory of Vibration with Applications", CBS Publishers and Distributors, New Delhi, 1990.

2.Rao, J.S., & Gupta, K. "Introductory Course on Theory and Practice of Mechanical Vibrations", New Age International Ltd., 1984.

3. **Den Hartog, J.P** "Mechanical Vibrations", Dover Publication, 1990.

4. Update CEP, ISTE New Delhi "Condition Monitoring and condition based maintenance".

Course Code	Course Title	Type	L	T	P	Credit	Total
MTMD17F241	FINITE ELEMENT ANALYSIS	SC	4	1	0	5	6

Prerequisites: Engg. Mathematics, Strength of Materials, FEM, Theory of Elasticity

Course Objectives

1. To present the Finite element method (FEM) as a numerical method for engineering analysis of continua and structures
2. To present Finite element formulation using variational and weighted residual approaches
3. To present Finite elements for the analysis of bars & trusses, beams & frames, plane stress & plane strain problems and 3-D solids, for thermal and dynamics problems.

Course Outcome:

After completion of the course the student will be able to:

1. Describe the different types of analysis methods, types of FE elements, various approaches in Finite Element Method,
2. Derive Hermite Shape function and apply it to solve beam problems.
3. Compute Eigen Vector and Eigen Values of 1D and 2 D problems
4. Determine the stiffness matrix and unknown DOFs of Trusses and derive shape functions for Higher Order Elements

Course Contents

UNIT 1

Formulation Techniques: Methodology, Engineering problems and governing differential equations , finite elements,Variational methods-potential energy method, Raleigh Ritz method, strong and weak forms, Galerkin and weighted residual methods, calculus of variations, Essential and natural boundary conditions.

One-dimensional finite element methods: Bar elements, temperature effects. Element matrices, assembling of global stiffness matrix, Application of boundary conditions, Convergence: Requirements for convergence, h-refinement and p-refinement, complete and incomplete interpolation functions, Pascal's triangle. Elimination and penalty approaches, solution for displacements, reaction, stresses, temperature effects, Quadratic Element, Heat transfer problems: One-dimensional, conduction and convection problems.

12Hours

UNIT 2

Trusses: Element matrices, assembling of global stiffness matrix, solution for displacements, reaction, stresses, 2-D and 3-D truss problems.

Beams and Frames: Element matrices, assembling of global stiffness matrix, solution for displacements, reaction, stresses.

12Hours

UNIT 3

Two dimensional problems: CST, LST, four noded and eight nodded rectangular elements, Lagrange basis for triangles and rectangles, serendipity interpolation functions. Axisymmetric formulations, Element matrices, boundary conditions, Axisymmetric Problems. Heat Transfer problems: Conduction and convection.

12Hours

UNIT 4

Iso-parametric formulation: Concepts, sub parametric, super parametric elements, numerical integration. Higher order Elements.

Finite elements in Structural Dynamics: Dynamic equations, Eigen value problems, and their solution methods, simple problems.

12Hours

TEXT BOOK:

1.Bhavikatti S.S,(2006), **'**Finite Element Analysis', 4th edition, New Delhi, New Age International publishers.

2. ChandrapatlaT.R. andA.D Belegunde A.D, (2008), **'**Finite Elements in Engineering', 3rd edition, New Delhi, PHI.

REFERENCES:

1. Daryl. L. Logon, (2001),Finite Element Methods, 3rd edition, New york, Thomson Learning.
2. Cook R.D, D.S Maltus D.S, PleshaM.E.,Witt R.J.(2009),Concepts and applications of Finite Element Analysis, 4th Edition, London, Wiley.
3.

Course Code	Course Title	Type	L	T	P	Credit	Total
MTMD17F242	**ADVANCED MATERIALS**	**SC**	**4**	**1**	**0**	**5**	**6**

Prerequisites: Material Science, Manufacturing Technology, Composite Materials.

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:

After completion of the course the student will be able to:

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

Course Contents

UNIT 1

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

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

12Hours

UNIT 2

Composites: Definition,classification and characteristics of composite materials ,Volume fraction -laminated composites particulate composites, fibrous composites, Types of reinforcements, their shape and size,production and properties of fibber reinforced plastics, Metal Matrix composites and ceramic matrix composites, Applications.

Processing of Polymers: composites, ceramics ,thermal spraying ,Ion beam machining diamond coating techniques,tribological Applications.

12Hours

UNIT 3

Smart Materials : Overview of Smart Materials, Structures and Products Techno logies. Smart Materials (Physical Properties)Piezoelectric Materials, Electrostrictive Materials, Magnetostrictive Materials, **Magnetoelectric Materials.** Magnetorheological Fluids, Electrorheological Fluids, Shape Memory Materials, FiberOptic Sensors. Smart Sensor, Actuator and Transducer Technologies. **12Hours**

UNIT 4

Nanotechnology: Nanopowders and nanomateirals, methods of preparation –plasma arcing, chemical vapour deposition, electro deposition, sol-gel synthesis, ball milling, comparative studies of the advantages and disadvantages of nano powder production technologies.

Powder Metallurgy: Process details and special characteristics of powder metallurgy process. Compaction techniques like CIP & HIP (Cold Isostatic and Hot Isostatic pressing) Applications of Powder metallurgy. High temperature alloys: Classification of Titanium alloys, properties and applications, heat treatment and machining of Ti alloys.

12Hours

TEXT BOOKS:

1. Materials Science & Engineering -**William D. Callister Jr.** an introduction, 4th edition. John Wiley & Sons.
2. .Engg. Materials & their applications- **R. A. Flinn& P. K. Trojan**, 4thedition, Jaico Publishing House.
3. Smart Materials and Structures- **M. V. Gandhi and B. So Thompson - Chapman & Hall,** London; New York – 1992.

REFERENCE BOOKS:

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

Course Code	Course Title	Type	L	T	P	Credit	Total
MTMD17F243	**ADVANCED MACHINE DESIGN**	**SC**	**4**	**1**	**0**	**5**	**6**

Prerequisites: Engg. Mathematics, Strength of Materials, Material Science, Machine Design, Fracture Mechanics**.**

Course Objective:

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 Outcome:

After completion of the course the student will be able to:

1. Classify and explain the art of design methodology by analysis and damage tolerance methods.
2. Discuss an overview of mechanical behaviour which includes tensile, fatigue and creep.
3. Illustrate the micro mechanisms of brittle and ductile fracture.
4. Examine the fatigue and fracture behaviour of materials.

Course Content

UNIT 1

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 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.

12 Hours

UNIT 2

Stess-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 behaviour, S-N curve representation and approximations, Constant life diagrams, Fatigue life estimation using S-N approach.

Strain-Life(ε-N)approach: Monotonic stress-strain behavior ,Strain controlled test methods ,Cyclic stress-strain behavior ,Strain based approach to life estimation, Determination of strain life fatigue properties, Mean stress effects, Effect of surface finish, Life estimation by ε-N approach. **12 Hours**

UNIT 3

LEFM Approach: LEFM concepts, Crack tip plastic zone, Fracture toughness, Fatigue crack growth, Mean stress effects, Crack growth life estimation. Notches and their effects: Concentrations and gradients in stress and strain, S-N approach for notched membranes, mean stress effects and Haigh diagrams, Notch strain analysis and the strain – life approach, Neuber's rule, Glinka's rule, applications of fracture mechanics to crack growth at notches.

12 Hours

UNIT 4

Fatigue from Variable Amplitude Loading: 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. **Surface Failure:** Introduction, Surface geometry, Mating surface, Friction, Adhesive wear, Abrasive wear, Corrosion wear, Surface fatigue spherical contact, Cylindrical contact, General contact, Dynamic contact stresses, Surface fatigue strength. **12Hours**

TEXT BOOKS:

1. Ralph I. Stephens, Ali Fatemi, Robert, Henry o. Fuchs, "Metal Fatigue in engineering", John wileyNewyork, Second edition. 2001.

2. Jack. A. Collins, John Wiley, Failure of Materials in Mechanical Design, Newyork 1992.

3. Robert L. Norton , "Machine Design", Pearson Education India, 2000

REFERENCE BOOKS:

1. S.Suresh , "Fatigue of Materials", Cambridge University Press, -1998

2. Julie.A.Benantine , "Fundamentals of Metal Fatigue Analysis", Prentice Hall,1990

3. Fatigue and Fracture, ASM Hand Book, Vol 19,2002.

Course Code	Course Title	Type	L	T	P	Credit	Total
MTMD17F251	MECHANICS OF COMPOSITE MATERIALS	SC	4	1	0	5	6

Prerequisites: Material Science & Metallurgy, Strength of Materials, Composite Materials, Manufacturing Technology.

Course objective:

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:

After completion 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 analyze macro mechanical analysis of a laminate.
4. Determine the coefficient of thermal expansion and other thermal properties of laminates

Course Contents

UNIT-1

Introduction to composite materials: Classification and characteristics of composite materials, Mechanical behavior of composites, Basic terminology of laminated fiber reinforced composite materials, Advantages, Applications, Different types of fibers and matrix materials, Manufacture of laminated fiber reinforced composite materials - Hand layup, bag molding, Resin transfer molding, filament winding and pultrusion. **12Hours**

UNIT-2

Macromechanicalbehavior of a lamina – Introduction, Stress-strain relations for anisotropic materials - generalized hooks law, Stiffnesses, compliances and engineering constants for orthotropic materials, Restrictions on engineering constants, Stress-strain relations for plane stress in orthotropic materials, Stress-strain relations for a lamina of arbitrary orientation, Invariant properties of an orthotropic lamina, strengths of an orthotropic lamina, Biaxial criteria for an orthotropic lamina. **12Hours**

UNIT-3

Micromechanical behavior of lamina: Introduction, Mechanics of materials approach to stiffness, Elasticity approach to stiffness, comparison of approaches to stiffness, Mechanics of materials approach to strength.

Macro mechanical behavior of laminate: Introduction, Classical lamination theory, Special cases of laminate stiffnesses, Theoritical versus measured laminate stiffnesses, Strength of laminates, Inter laminar stresses. **12Hours**

UNIT-4

Bending of laminated plates: Introduction, Governing equation for bending of laminated plates, Deflection of simply supported laminated plates under distributed transverse load.

Introduction to design of composite structures: Introduction, Structural design, Materials selection, Laminate joints, Design requirements and design failure criteria, Optimization concepts, Design analysis philosophy for composite structures. **12Hours**

TEXT BOOK:

1. Mechanics of composite materials,**R. M. Jones,** Taylor and Francis.

REFERENCES:

1. Analysis and performances of Fiber composites ,**B. D. Agarwal, L. J. Broutman and K. Chandrasekhara,** John Wiley & Sons, Inc.
2. Primer on composite materials,**J. C. Halpin**, Technomic Publishing Company, Inc

Course Code	Course Title	Type	L	T	P	Credit	Total
MTMD17F252	**ROBOTICS**	**SC**	**4**	**1**	**0**	**5**	**6**

Prerequisites: CAD/CAM/CIM

Course Objectives :

1. Learn the concepts of robot representation using concepts of kinematics & mathematics.
2. Learn & understand the Matrix Representation, Homogeneous transformation, forward and inverse Kinematics
3. Learn basic methods & algorithms of Trajectory planning: avoidance of obstacles uninformed path search.
4. Learn the Image processing Vs image analysis, image Acquisition.

Course outcome:

After Completion of the course student shall be able to:

1. Formulate the Mathematical representation of Robots, Kinematics of Robot
2. Determine the Trajectory planning
3. Understand the basic principle of Machine Vision systems, image acquisition & image components.
4. Apply the knowledge to design actual robots to perform basic operations such as pick & place line follower robots etc.

Course Content

Unit 1

Robotics Introduction:Basic Structure,Classification of robot and Robotic systems –laws of robotics – robot motions – work space, precision of movement.

Types of joints : Rotary, prismatic, cylindrical & spherical joints.Position& orientation of rigid body, universal frames & fixed frames, Euler angle representation for xyz, zyz frames.**12Hours**

Unit 2

Mathematical representation of Robots,Kinematics of Robot : Introduction, Matrix Representation, Homogeneous transformation, forward and inverse Kinematics, Inverse Kinematics Programming, Degeneracy, dexteritying, transformation matrix for 3R manipulator, puma 560 & SCARA manipulator.
12Hours

Unit 3

Trajectory planning : avoidance of obstacles uninformed path search, informed path search, A* & B* algorithms, bus algorithms with tactile sensors & case studies.**12Hours**

Unit 4

Machine Vision systems : Introduction – Image processing Vs image analysis, image Acquisition, digital Images – Sampling and Quantization – Image definition, levels of Computation. **12Hours**

TEXT BOOK:

1. Saeed B. Niku, **Introduction to Robotics: Analysis, Systems, Applications**, 2nd edition, Pearson Education India, PHI 2003 (ISBN 81-7808-677-8)

REFERENCES:

1. M.P. Groover, "**Industrial Robotics Technology, Programming and Applications"**,_McGraw-Hill, USA, 1986.
2. Ramesh Jam, RangachariKasturi, 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	Type	L	T	P	Credit	Total
MTMD17F253	**Plates and Shells**	**SC**	**4**	**1**	**0**	**5**	**6**

Prerequisite: Student should have attended course on structural analysis.

CourseObjective:

1. To enable the students to understand Different Boundary Conditions for plates.
2. Provide systematic basic knowledge for Circular plates subjected to Axi-symmetrical loads
3. To enable the students to understand Finite difference method, Finite element methodology for plates,
4. Formulate to understand the basic principles of the Membrane and bending theory for singly curved and doubly curved shells

Course Outcome:
After completion of the course the student will be able to

1. Demonstrate the fundamentals of Simple bending of Plates and analyze the Plates subjected to lateral loads
2. Formulate Circular plates subjected to Axi-symmetrical loads
3. Apply the Rayleigh-Ritz method for bending of plates and shells.
4. Derive the equations of Shells and Classification of shells.

Course Contents

Unit 1

Simple bending of Plates-Assumptions in thin plate theory,Different relationships, Different Boundary Conditions for plates, Plates subjected to lateral loads,Navier's method for simply supported plates, Levy's method for general plates ,Example problems with different types of loading.
12 Hours

Unit 2

Circular plates subjected to Axi-symmetrical loads,concentrated load, uniformly distributed load and varying load ,Annular circular plate with end moments.
12 Hours

Unit 3

Rayleigh-Ritz method :Application to different problems ,Finite difference method,Finite element methodology for plates,Orthotropic Plates Bending of anisotropic plates with emphasis on orthotropic plates ,Material Orthotropy, Structural Orthotropy ,Plates on elastic foundation. **12 Hours**

Unit 4

Shells- Classification of shells - Membrane and bending theory for singly curved and doublycurved shells - Various approximations - Analysis of folded plates.
12 Hours

TEXT BOOKS :

1. Theory of plates and shells by S.P.Timoshenko and S.Woinowsky-Krieger, McGraw-Hill, 1959.

2. Stresses in plates and shells by A.C.Ugural, McGraw-Hill, 1999.

REFERENCE BOOKS:

1. Analysis of plates by T.K.Varadan and K.Bhaskar ,Narosa Publishing House, 1999.
2. "Stresses in Shells" by Flugge. Blaisdell Publishing Co, 1966 3. Design and construction of concrete shell roofs by G.S.Ramaswamy, CBS Publishers& Distributors,1986.
3.Rudolph Szilard, Theory and Analysis of Plates,Prentice Hall, New Jercy 1986.
4.Stephen .P. Timoshenko &Woinowsky Krieger, Theory of Plates and Shells,McGraw Hill, 1984

Course Code	Course Title	Type of	L	T	P	Credit	Total
MTMD17F261	**FRACTURE MECHANICS**	**SC**	**4**	**0**	**1**	**5**	**6**

Prerequisites: Engg. Mathematics, Theory of Elasticity, Theory of Plasticity, Material Science.

Course Objective:

1. To enable the students to understand the Fundamental Concepts, Historical perspective, Linear Elastic Fracture Mechanics.
2. Provide systematic basic knowledge for Crack-Tip-Opening Displacement, The J Contour integral, Relationships Between J and CTOD,
3. To enable the students to understand Ductile Fracture, Cleavage, the Ductile-Brittle Transition, and Intergranular Fracture.
4. 4.Knowledge about the General Considerations, KIc Testing, K-R Curve Testing

Course Outcome:

After completion of the course the student will be able to

1. Demonstrate the fundamentals of Stress Analysis of Cracks, Relationship between K and G
2. Formulate the Elastic-Plastic Fracture Mechanics & Dynamic and Time-Dependent Fracture
3. Determine the Fracture Mechanisms in Metals& Non Metals
4. .Derive the Fracture Toughness, Testing of Metals & Non Metals

Course Contents

UNIT 1

Fundamental Concepts: Introduction, Historical perspective, Linear Elastic Fracture Mechanics, An Atomic View of Fracture, Stress Concentration Effect of Flaws, The Griffith Energy Balance, The Energy Release Rate, Instability and the R Curve, Stress Analysis of Cracks, Relationship between K and G, Crack-Tip Plasticity, K-Controlled Fracture, Plane Strain Fracture, Mixed-Mode Fracture, Interaction of Multiple Cracks.
12 Hours

UNIT 2

Elastic-Plastic Fracture Mechanics: Crack-Tip-Opening Displacement, The J Contour integral, Relationships Between J and CTOD, Crack-Growth Resistance Curves, Controlled Fracture, Crack-Tip Constraint Under Large-Scale Yielding, Numerical problems.
Dynamic and Time-Dependent Fracture: Dynamic Fracture and Crack Arrest, Effect of fatigue on Creep Crack Growth, Viscoelastic Fracture Mechanics.
12 Hours

UNIT 3

Fracture Mechanisms in Metals: Ductile Fracture, Cleavage, the Ductile-Brittle Transition, Intergranular Fracture.
Fracture Mechanisms in Non-metals: Engineering Plastics, Ceramics and Ceramic Composites, Micro crack Toughening, Concrete and Rock.
12 Hours

UNIT 4

Fracture Toughness Testing of Metals: General Considerations, KIc Testing, K-R Curve Testing, J Testing of Metals, CTOD Testing, Dynamic and Crack-Arrest Toughness, Fracture Testing of Weldments, Testing and Analysis of Steels in the Ductile-Brittle Transition Region, Qualitative Toughness Tests, Numerical problems.
Fracture Testing of Non-metals: Fracture Toughness Measurements in Engineering Plastics, Precracking and Other Practical Matters, Interlaminar Toughness of Composites, Ceramics.**12 Hours**

TEXT BOOK:

1. **Fracture Mechanics:** Fundamentals and Applications by T.L. Anderson, CRC Press, Florida.

REFERENCE BOOKS:

1. Elementary Engineering Fracture Mechanics by **D. Broek, MartinusNijhoff.**
2. The Practical Use of Fracture Mechanics by **D. Broek, Kluwer** Academic Publishers.
3. Deformation and Fracture Mechanics of Engg. Materials by **R. W. Hertzberg,** John-Wiley & Sons.
4. Fracture and Fatigue Control in Structures: Applications of fracture mechanics by **J.M. Barsom and S.T. Rolfe,** ASTM International.
5. Mechanics and Mechanisms of Fracture: An Introduction by **A. F. Liu,**ASTM International.

Course Code	Course Title	Type	L	T	P	Credit	Total
MTMD17F262	**MECHATRONICS PRODUCT DESIGN**	**SC**	**4**	**1**	**0**	**5**	**6**

Prerequisites: Automation, CAD/CAM, Engg. Mathematics, Basic Electronics, Mechatronics and Microprocessor

Course Objective

1. To educate the student regarding integration of mechanical, electronics, electrical and computer systems in the design of CNC machine tools, Robots etc.
2. To provide students with an understanding of the Mechatronic Design Process, actuators, Sensors, transducers, Signal Conditioning, MEMS and Microsystems and also the Advanced Applications in Mechatronics

Course Outcome:

After completion of the course the student will be able to

1. Appreciate multi-disciplinary nature of modern engineering systems and specifically mechanical engineering students to collaborate with Electrical, Electronics, Instrumentation and Computer Engineering disciplines.
2. Analyze constructions and models of Engineering Systems, rotational, translation, elected mechanical, Hydraulic mechanical system. System Transfer functions.
3. Develop the conceptual design of Mechatronic Product using available software CAD packages MATLAB and SIMULINK
4. Apply the design procedures on different types of machine tool and/or machine tool components using mechatronics concept.

Course Contents

UNIT 1

Introduction to Mechatronics systems and components: Principles of basic electronics - Digital logic, number system logic gates, Sequence logic flip flop system, JK flip flop, D-flip flop.

Microprocessors and their applications: Microcomputer computer structure/micro controllers, Integrated circuits - signal conditioning processes, various types of amplifiers, low pass and high pass filters.

12 Hours

UNIT 2

Sensors -sensors and transducers. Displacement, position proximity sensors, velocity, force sensors. Fluid pressure temperature, liquid level and light sensors. Selection of sensors., Actuators, Pneumatic and hydraulic systems, Mechanical actuation system. Electrical actuation system. Other Electrical / Electronic hardware in Mechatronic system.

12 Hours

UNIT 3

Principles of Electronic system communication, Interfacing, A.D and D.A Converters: Software and hardware principles and tools to build mechatronic systems. Basic system models mathematical models, mechanical and other system Building blocks.

System models : Engineering . Systems, rotational, translation, elected mechanical, Hydraulic mechanical system., System Transfer functions.

12 Hours

UNIT 4

First-second order system in series: Design and selection of Mechatronics systems namely sensors line encoders and revolvers, stepper and servomotors Ball screws, solenoids, line actuators and controllers with application to CNC system, robots, consumer electronics products etc, Design of a Mechatronic Product using available software CAD packages MATLAB and SIMULINK. **12 Hours**

REFERENCE BOOKS

1. Mechatronics by W.Bolton, published by Addison Worley Longman Pvt. Ltd., India Brander, Delhi.

2. Automation Production System System and CIMS by Mikel P Grooer, Phentice Hall of India Pvt. Ltd, New Delhi.

Course Code	Course Title	Type	L	T	P	Credit	Total
MTMD17F263	**COMPUTATIONAL FLUID DYNAMICS**	**SC**	**4**	**1**	**0**	**5**	**6**

Prerequisites: Fluid Mechanics, Dynamics of Machines, Engg. Mathematics.

Course Objective:

1. To provide the students with sufficient background to understand the mathematical representation of the governing equations of fluid flow and heat transfer.
2. To enable the students to solve one and two-dimensional ordinary and partial differential equations using traditional CFD tools.
3. To help the students solve fluid flow field using some popular CFD techniques.

Course Outcome:

After completion of the course the student will be able to

1. Possess the knowledge of CFD techniques, basic aspects of discretization and grid generation.
2. Solve fluid flow fields using CFD methods.
3. Model fluid flow problems and heat transfer.

Course Contents

UNIT 1

Introduction: Finite difference method, finite volume method, finite element method, governing equations and boundary conditions. Derivation of finite difference equations.

Solution methods: Solution methods of elliptical equations finite difference formulations, interactive solution methods, direct method with Gaussian elimination. Parabolic equations explicit schemes and Von Neumann stability analysis, implicit schemes, alternating direction implicit schemes, approximate factorization, fractional step methods, direct method with ridiagonal matrix algorithm. **12 Hours**

UNIT 2

Hyperbolic equations: explicit schemes and Von Neumann stability analysis, implicit schemes, multi step methods, nonlinear problems, second order one-dimensional wave equations.

Burgers equations: Explicit and implicit schemes, Runge-Kutta method. Formulations of incompressible viscous flows: Formulations of incompressible viscous flows by finite difference methods, pressure correction methods, vortex methods.

12 Hours

UNIT 3

Treatment of compressible flows: potential equation, Eluer equations, Navier-stokes system of equations, flowfield-dependent variation methods, boundary conditions, example problems.

Finite volume method: Finite volume method via finite difference method.

12 Hours

UNIT 4

Formulations for two and three-dimensional problems.**Standardvariational methods:** Linear fluid flow problems, steady state problems, Transient problems.

12 Hours

TEXT BOOK:

1. **Computational fluid dynamics**, T. J. Chung, Cambridge University press, 2002.

REFERENCE BOOK:

1. **Text book of fluid dynamics**, Frank Chorlton, CBS Publishers & distributors, 1985.

THIRD SEMESTER

Course Code	Course Title	Type	L	T	P	Credit	Total
MTMD17F311	AUTOMOBILE SYSTEM DESIGN	SC	4	1	0	5	6

Prerequisites:IC Engines,TurboMachines,Automobile Engineering.

Course Objective

1. To enable the students to understand Aerodynamic Shapes, drag forces for small family cars
2. Provide systematic basic knowledge of Combustion fundamentals, combustion chamber design
3. To enable the students to understand Design of transmission systems – gearbox
4. Formulate the to understand the basic principles of Heat exchangers, application to design of cooling system

Course Outcome

After completion of the course the student will be able to

1. Demonstrate the fundamentals of Body Shapes & Fuel Injection
2. Formulate design for both SI & C. I. Engines.
3. Determine the Transmission &Suspension System
4. Describe the Cooling & Exhaust System and Emission Control

Course Content

UNIT 1

Body Shapes: Aerodynamic Shapes, drag forces for small family cars.
Fuel Injection: Spray formation, direct injection for single cylinder engines (both SI & CI), energy audit. **12 Hours**

UNIT 2

Design of I.C. Engine I: Combustion fundamentals, combustion chamber design, cylinder head design for both SI & C. I. Engines.
Design of I.C. Engine II: Design of crankshaft, camshaft, connecting rod, piston & piston rings for small family cars (max up to 3 cylinders).**12 Hours**

UNIT 3

Transmission System: Design of transmission systems – gearbox (max of 4-speeds), differential.
Suspension System: Vibration fundamentals, vibration analysis (single & two degree of freedom, vibration due to engine unbalance, application to vehicle suspension.
12 Hours

UNIT 4

Cooling System: Heat exchangers, application to design of cooling system (water cooled).
Emission Control: Common emission control systems, measurement of missions, exhaust gas emission testing.
12 Hours

TEXT BOOKS

1. Design of Automotive Engines, - A .Kolchin& V. Demidov, MIR Publishers, Moscow
2. The motor vehicle, Newton steeds &Garratte- Iliffee& sons Ltd., London
3. I.C. Engines - Edward F Obert, International text book company.

REFERENCE BOOKS

1. Introduction to combustion- Turns
2. Automobile Mechanic -,N.K.Giri, Khanna Publications, 1994
3. I.C. Engines -Maleev, McGraw Hill book company, 1976
4. Diesel engine design -HeldtP.M.,Chilton company New York.
5. Problems on design of machine elements -V.M. Faires&Wingreen, McMillan Company., 1965
6. Design of I.C.Engines -John Heywood, TMH

Course Code	Course Title	Type	L	T	P	Credit	Total
MTMD17F312	**ADVANCED MANUFACTACTURINGPROCESS**	**SC**	**4**	**1**	**0**	**5**	**6**

Prerequisites: Material Science,Metal cutting and Metal forming,MP-III

Course Objective

1. To enable the students to understand sheet metal forming and its plastic behavior
2. Provide systematic basic knowledge of yield criteria and formability of sheet metal
3. To enable the students to Simulate the Parts of Forming Processes
4. Formulate the to understand the basic principles of rolling, drawing, extrusion and composite material

Course Outcome

After completion of the course the student will be able to

1. Demonstrate the fundamentals of sheet metal forming
2. Formulate Theoretical Predictions of the Forming
3. DemonstrateNumerical Simulation of the Sheet Metal Forming
4. Describe rolling, drawing, extrusion and composite material

Course Content:

UNIT 1

Finite Element Models of Sheet Metal Forming Processes: Introduction, fundamentals of continuum mechanics- strain and stress measurement,Material Models , FE-Equations for Small Deformations, FE-Equations for Finite Deformations, Flow Approach,Eulerian FE-Formulations for Rigid-PlasticSheet Metal Analysis, The Dynamic, Explicit Method, Historical Review of Sheet Forming Simulation.
Plastic Behaviour of Sheet Metal: Anisotropy of Sheet Metals,Uniaxial and biaxial Anisotropy Coefficients, Yield Criteria for Isotropic Materials, ClassicalYield Criteria for Anisotropic Materials. **12 Hours**

UNIT 2

Advanced Anisotropic Yield Criteria: Banabic-Balan-Comsa (BBC) 2005 Yield Criterion, Banabic-Balan-Comsa (BBC)2008 Yield Criterion,Recommendations on the Choice of the Yield Criterion, Modeling of the Bauschinger Effect.
Formability of Sheet Metals: Evaluation of the Sheet Metal Formability-method based on simulation test and limit dome height diagram, Forming LimitDiagram-definition,experimental determination, methods of determining the limit strain, factors influencing the forming limit, Theoretical Predictions of
the Forming Limit Curves, Semi-empirical Model. **12 Hours**

UNIT 3

Numerical Simulation of the Sheet Metal Forming Processes: Simulation of the Elementary Forming Processes. Simulation of the IndustrialParts Forming Processes, Robust Design of Sheet Metal Forming Processes, The Spring-back Analysis, Computer Aided Spring- back Compensation.
Forging: Classification, various stages during forging, Forging equipment, brief description, deformation in compression, forging defects. Residual stressesin forging.
12 Hours

UNIT 4

Rolling: Classification, forces and geometrical relationships in rolling. Deformation in rolling, Defects in rolled products, Residual stresses inrolled products. Torque and Horsepower.
Drawing and Extrusion: Principles of Rod and wire drawing, variables in wire drawing, Residual stresses in rod, wireand tube drawing, Defects in Rod and wire drawing. Extrusion equipment, Classification, variables in extrusion, Deformation in extrusion, Extrusion defects,Work done in extrusion.
Composite Materials and Honeycomb Structures: Manufacturing processes and environmental requirements for manufacturing of compositecomponents, NDT methods and quality control, sandwich structures and adhesive bonding. Heat Treatment Processes: Purpose of heat treatment and theoryof heat treatment processes, heat treatment of alloys of aluminum, magnesium, titanium, steel and case hardening.
12 Hours
TEXT BOOKS

1. Dorel Banabic,Sheet Metal Forming Processes: Constitutive Modeling and Numerical Simulation, Springer, 2010.
2. Dieter G.E. Mechanical Metallurgy, McGraw Hill, 1986.
3. ASM Metals Handbook –Volume II.

REFERENCE BOOKS:

1. Aircraft Materials and Manufacturing Process - **George F.Titterton,** published by Himalayan books, New Delhi, 1968.

2. Aircraft Production Technology and Management - **ChennaKeshu S and Ganapathy K K,** Interline Publishing, Bangalore, 1993.
3.**SachG**"Fundamentals of working of metals" Pergamon Press.
4. N Bhatnagar, T S Srivatsan, "Processing and Fabrication of Advanced Materials", IK International
5. Phillip F. Ostwald, Jairo Muñoz,"Manufacturing processes and systems", John Wiley, 1997.
6. Stephen F. Krar, Arthur Gill, "Exploring advanced manufacturing technologies", Industrial Press, 2003.
7. Kobayashi "Metal forming and finite element methods", Oxford, 1989.
8. PrakashMahadeo Dixit, Uday S. Dixit,"Modeling of metal forming and machining processes", Springer, 2008.
9. Dorel Banabic,"Advanced Methods in Material Forming", Springer, 2007.
10. Schuler GmbH.,"Metal forming handbook", Springer, 1998.

Course Code	Course Title	Type	L	T	P	Credit	Total
MTMD17F313	**DESIGN OPTIMIZATION**	**SC**	**4**	**1**	**0**	**5**	**6**

Prerequisites: Operation Research,Project Management,Optimization Techniques

Course Objective:

1. It aims at finding out Engineering Design Practice and Applications of Optimization in Engineering Design
2. It provides the designer to , Design Variables and Design Constraints
3. It helps in solving the Gradient Based Optimization Methods – Dual and Direct.
4. It gives an idea about the Manufacturability in Optimization Problems

Course Outcome:
After completion of the course the student will be able to

1. Identify the fundamentals of Engineering Design Practice.
2. Test the Optimum Design Problem Formulation.
3. Detect the Gradient Based Optimization Methods.
4. Investigate the Manufacturability in Optimization Problems,Design Interpretation and Dynamic Programming.

Course Content:

UNIT 1

Engineering Design Practice: Evolution of Design Technology, Introduction to Design and the Design Process, Design versus Analysis, Role ofComputers in Design Cycle, Impact of CAE on Design, Numerical Modeling with FEA and Correlation with Physical Tests.
Applications of Optimization in Engineering Design: Automotive, Aerospace and General Industry Applications, Optimization of Metallic and CompositeStructures, Minimization and Maximization Problems, MDO and MOO.
12 Hours

UNIT 2

Optimum Design Problem Formulation: Types of Optimization Problems, The Mathematics of Optimization, Design Variables and DesignConstraints, Feasible and Infeasible Designs, Equality and Inequality Constraints, Discrete and Continuous Optimization, Linear and Non Linear Optimization.

Optimization Theory – Fundamental Concepts, Global and Local Minimum, Gradient Vector and Hessian Matrix, Concept of Necessary and SufficientConditions, Constrained and Unconstrained Problems, Lagrange Multipliers and Kuhn Tucker Conditions.

12 Hours

UNIT 3

S**ensitivity Analysis, Linear and Non Linear Approximations. Gradient Based Optimization Methods** – Dual and Direct.

Optimization Disciplines: Conceptual Design Optimization and Design Fine Tuning, Combined Optimization, Optimization of Multiple Static and DynamicLoads, Transient Simulations, Equivalent Static Load Methods. Internal and External Responses, Design Variables in Each Discipline.

12 Hours

UNIT 4

Manufacturability in Optimization Problems: Design for Manufacturing, Manufacturing Methods and Rules, Applying ManufacturingConstraints to Optimization Problems.

Design Interpretation: Unbound Problems, Over Constrained Problems, Problems with No of Multiple Solutions, Active and Inactive Constraints,Constraint Violations and Constraint Screening, Design Move Limits, Local and Global Optimum .

Dynamic Programming: Introduction, Multistage decision processes, Principle of optimality, Computational Procedure in dynamicprogramming, Initial value problem, Examples.**12 Hours**

TEXT BOOKS:

1. **S.S.Rao, Engineering** Optimization: Theory and Practice, John Wiley, 2009
2. **JasbirArora**, Introduction to Optimum Design, McGraw Hill, 2011.

REFERENCE BOOKS:

1. Optimisation and Probability in System Engg - **Ram, Van Nostrand.**
2. Optimization methods - **K. V. Mital and C. Mohan,** New age International Publishers, 1999.
3. Optimization methods for Engg. Design - **R.L Fox, Addison** – Wesley, 1971.

Course Code	Course Title	Type	L	T	P	Credit	Total
MTMD17F320	**Automotive Systems**	**OE**	**4**	**1**	**0**	**5**	**6**

Prerequisites:IC Engines, Turbo Machines, Automobile Engineering MSM

Course Objective:

1. To enable the students to understand Aerodynamic Shapes, drag forces for small family cars
2. Provide systematic basic knowledge of Combustion fundamentals, combustion chamber design
3. To enable the students to understand Design of transmission systems – gearbox
4. Formulate the to understand the basic principles of Heat exchangers, application to design of cooling system

Course Outcome:
After completion of the course the student will be able to

1. Explain the fundamentals of Body Shapes & Fuel Injection
2. Formulate design for both SI & C. I. Engines.
3. Determine the Transmission &Suspension System
4. Describe the Cooling & Exhaust System and Emission Control

Unit:1 **Body Shapes & Fuel Injection** 12 Hours

Body Shapes: Aerodynamic Shapes, drag forces for small family cars.

Fuel Injection: Spray formation, direct injection for single cylinder engines (both SI & CI), and energy audit.

Unit:2 **Design of I.C. Engine** 12 Hours

Design of I.C. Engine I: Combustion fundamentals, combustion chamber design, cylinder head design for both SI & C. I. Engines.

Design of I.C. Engine II: Design of crankshaft, camshaft, connecting rod, piston & piston rings for small family cars (max up to 3 cylinders).

Unit:3 **Transmission &Suspension System** 11 Hours

Transmission System: Design of transmission systems – gearbox (max of 4-speeds), differential.

Suspension System: Vibration fundamentals, vibration analysis (single & two degree of freedom, vibration due to engine unbalance, application to vehicle suspension.

Unit:4 **Cooling & Exhaust System** 10 Hours

Cooling System: Heat exchangers, application to design of cooling system (water cooled).

Emission Control: Common emission control systems, measurement of missions, exhaust gas emission testing.

Text Books
1. **Design of Automotive Engines**, - A .Kolchin& V. Demidov, MIR Publishers, Moscow
2. **The motor vehicle,** Newton steeds &Garratte- Iliffee& sons Ltd., London
3. **I.C. Engines**- Edward F Obert, International text book company.

References
1. **Introduction to combustion**- Turns
2. **Automobile Mechanic** -,N.K.Giri, Khanna Publications, 1994

3. **I.C. Engines**-Maleev, McGraw Hill book company, 1976
4. **Diesel Engine Design**-HeldtP.M.,Chilton company New York.
5. **Problems on design of machine elements** -V.M. Faires&Wingreen, McMillan Company., 1965
6. **Design of I.C.Engines** -John Heywood, TMH

Course Code	Course Title	Type	L	T	P	Credit	Total
MTMD17F330	**PROJECT PHASE 1**	**SC**	**0**	**0**	**10**	**10**	**20**

Course Objectives:

1. To carry out literature survey in the selected area
2. To identify the problem in real time application
3. To make the students to convert their ideas in to reality.

Course Outcomes:

After completion of the course the student will be able to

1. Collect relevant literature in the selected domain of the project
2. Identify the problems in the real time application and communicate through presentation.

The students have to start project and select the problems which is relevant to an industry or in the society or any innovative ideas. In project phase-I student has to work for the literature work and problems has to be clearly defined at the end semester and present the progress of the work in two phases which will be evaluated. 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 for each student.

Project work phase 1 comprises of literature survey, review paper writing, problem formulation, identification of tools and techniques, and methodology for the project.

FOURTH SEMESTER

Course Code	Course Title	Type	L	T	P	Credit

MTMD17F410	**DISSERTATION**	**HC**	**0**	**0**	**16**	**16**

Course Objectives:

1. To identify a specific problem for the current need of the society and collecting information related to the same through detailed review of literature.
2. To develop the methodology to solve the identified problem
3. To train the students in preparing project reports and to face reviews and viva-voce examination.
4. To solve the identified problem based on the formulated methodology.
5. To develop skills to analyze and discuss the test results, and make conclusions

Course Outcomes:

1. At the end of the course the students will have a clear idea of their area of work and they will be in a position to carry out the remaining phase II work in a systematic way
2. On completion of the project work students will be in a position to take up any challenging practical problem in the field of engineering design and find better solutions to it.

The student individually works on a specific topic approved by director, School of Mechanical Engineering under the guidance of a faculty member who is familiar in their respective area of interest. The student can select any topic which is relevant to the area of Machine Design & present scenarios as per the technological advancement .The topic may be analytical with validations, experimental and case studies.

At the end of the semester, a detailed report on the work done should be submitted which contains clear definition of the identified problem, detailed literature review related to the area of work and methodology for carrying out the work with right relevant conclusion

After completing the work to the satisfactory level for the award of M.Tech degree. A detailed report should be prepared and submitted to the school. The students will be evaluated based on the report submitted and the viva-voce examination by a panel of examiners including one external examiner. Project work should have an outcome in the form of publication in a reputed National/International Journal or a patent filing.

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:

1. Willingness to learn
2. Self-motivation
3. Team work
4. Communication skills and application of these skills to real scenarios
5. Requirement of gathering, design and analysis, development and testing skills
6. Analytical and Technical skills
7. Computer skills
8. Internet searching skills
9. Information consolidation and presentation skills
10. Role play
11. 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 Machine Design is not only the knowledge in the subject, but also the skill to do the job proficiently, team spirit and a flavour of innovation. This kept in focus, the CDC has designed the training process, which will commence from secondsemester along with the curriculum. Special coaching in personality development, career building, English proficiency, reasoning, puzzles, 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 School of Mechanical Engineering also has emphasised subject based skill training through lab practice, internship, project work, industry interaction and many such skilling techniques. The students during their day to day studies are made to practice these skill techniques as these are inbuilt in the course curriculum. Concerned teachers also continuously guide and monitor the progress of students.

The University has also established University-Industry Interaction and Skill Development Centre headed by a Senior Professor & Director 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 VikasYojana.

The University has also 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.

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 colleagues/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.

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 / neighbors.
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 classrooms.

Note: 1. Rules are revised / reviewed as and when required.
2. Healthy suggestions are welcome for betterment of Institution