REVA UNIVERSITY
Bengaluru, India

SCHOOL OF MECHANICAL ENGINEERING

M.Tech

in

Machine Design

HAND BOOK

2021-23

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

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BOS/ME/MDD/2014-15/01/30-09-2014
BOS/ME/MDD/2015-16/02/30-04-2015
BOS/ME/MDD/2016-17/03/23-05-2016
BOS/ME/MDD/2017-18/04/13-05-2017
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BOS/ME/MMD/2021-22/08/25-06-2022

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Rukmini Educational
Charitable Trust www.reva.edu.in

Chancellor's Message

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

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

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

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

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

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

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

Vice Chancellor's Message

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

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

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

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

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

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

Welcome to the portals of REVA University!

Dr. M.Dhanamjaya
Vice Chancellor, REVA University

Director'sMessage

With great pleasure, I welcome you to the PG Studies under the School of Mechanical Engineering. The School offers Undergraduate programs in Mechanical Engineering and Mechatronics 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. Narayana Swamy
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 PhD degrees. REVA has well qualified experienced teaching faculty of

whom majority are doctorates. The faculty is supported by committed administrative and technical staff. Over 13,000 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 No. 80 dated 27thFebruary, 2013. The University is empowered by UGC to award degrees any branch of knowledge under Sec.22 of the UGC Act. The University is a Member of Association of Indian Universities, New Delhi. The main objective of the University is to prepare students with knowledge, wisdom and patriotism to face the global challenges and become the top leaders of the country and the globe in different fields.

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

REVA consistently ranked as one of the top universities in various categories because of the diverse community of international students and its teaching excellence in both theoretical and technical education in the fields of Engineering, Management, Law, Science, Commerce, Arts, Performing Arts, and Research Studies. REVA offers 33 Undergraduate Programmes, 24 Full-time and 2 Part-time Postgraduate Programmes, 18 Ph. D Programmes, and other Certificate/ Diploma/Postgraduate Diploma Programmes in various disciplines.

The curriculum of each programme is designed with a keen eye for detail by giving emphasis on hands-on training, industry relevance, social significance, and practical applications. The University offers world-class facilities and education that meets global standards.

The programs being offered by the REVA University are well planned and designed after detailed study with emphasis with knowledge assimilation, applications, global job market and their social relevance. Highly

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

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

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

The University also has University-Industry Interaction and Skill Development Centre headed by a Senior Professor & Director facilitating skill related training to REVA students and other unemployed students. The University has been recognized as a Centre of Skill Development and Training by NSDC (National Skill Development Corporation) under Pradhan Mantri Kaushal 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 concentrates on training entire faculty to adopt the new tools and implement their use. The division further works on introducing various examination and administrative reforms.

To motivate the youth and transform them to become innovative entrepreneurs, successful leaders of tomorrow and committed citizens of the country, REVA organizes interaction between students and successful industrialists, entrepreneurs, scientists and such others from time to time. As a part of this exercise great personalities such as Bharat Ratna Prof. C. N. R. Rao, a renowned Scientist, Dr. N R Narayana

Murthy, Founder and Chairman and Mentor of Infosys, Dr. K Kasturirangan, Former Chairman ISRO, Member of Planning Commission, Government of India, Dr. Balaram, Former Director IISc., and noted Scientist, Dr. V S Ramamurthy, Former Secretary, DST, Government of India, Dr. V K Aatre, noted Scientist and former head of the DRDO and Scientific Advisor to the Ministry of Defense Dr. Sathish Reddy, Scientific Advisor, Ministry of Defense, New Delhi and many others have accepted our invitation and blessed our students and faculty members by their inspiring addresses and interaction.

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

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 is having 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. The school is conducting extracurricular and co-curricular activities 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 institutions to learn various aspects of industry. The school is having clubs and chapters which are MARS, ISHRAE Student Chapter, Foundrymen Society, Fluid Power Society, Tribology Society of India, SAE club, Inquisity 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, B.Tech. in Mechatronics 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 in mechanical and allied areas and research leading to well-qualified engineers who are innovative, entrepreneurial, successful in their career and committed to the development of the country."

Mission

- To impart quality education to the students and enhance their skills to make them globally competitive engineers in mechanical and allied areas.
- To promote multidisciplinary study, cutting edge research and expand the frontiers of engineers' profession in mechanical and allied areas.
- To create state-of-art facilities with advanced technology for providing students and faculty with opportunities for innovation, application and dissemination of knowledge.
- To prepare for critical uncertainties ahead for mechanical engineering and allied areas and to face the challenges through clean, green and healthy solution.
- 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, Chennai.
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** FormerProfessor,Dept.MechanicalEngineeringIIT Madras, Chennai. 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.

Sl No	Name, Designation & Affiliation	Status	Correspondence Address
1	**Dr. K. S. Narayanaswamy** Director, School of Mechanical Engineering, REVA University , Bengaluru	**Chair person**	Dr. K S Narayanaswamy, Director, School of ME, REVA University, Rukmini Knowledge Park, Yelahanka, Bengaluru - 560 064
2	**Mr. S. Hareesha** Senior Manager(Design) ARDC, HAL	**Member**	Mr. S. Hareesha ,Senior Manager(Design), Stress Group, ARDC, HAL , Bengaluru -37
3	**Mr.SaidappagoudaTelsang** Senior CAE Analyst, TCS	**Member**	Mr.SaidappagoudaTelsang Senior CAE Analyst, TCS , Bengaluru
4	**Dr. D. Mallikarjuna Reddy** HoD& Associate Professor Vellore Institute of Technology	**Member**	Dr. D. Mallikarjuna Reddy,HOD &Associate Professor, Department of Design & Automation, School of Mechanical Engineering, Vellore Institute of Technology, Vellore,
5	**Dr. M R Ramesh** Associate Professor NITK	**Member**	Dr. M R Ramesh,Associate Professor, Department of mechanical Engineering, NITK Surathkal.
6	**Dr. Vidyasagar H N** Professor, Dept of Mechanical Engg. UVCE, Bangalore	**Member**	Dr. VidhyaSagar, Professor, Dept. of Mechanical Engg.UVCE, Bengaluru
7	**Dr. Sudheer Reddy J** Professor, NMIT	**Member**	Dr. Sudheer Reddy J Professor & HOD, Dept of Mechanical Engineering, NMIT Bengaluru,
8	**Dr. Manjunath L. H** Professor, School of ME, REVA University	**Member (Internal)**	Dr. Manjunath L. H Professor, School of Mechanical Engineering REVA University, Bengaluru 560064
9	**Dr. Hemanth K** Associate Professor, School of ME, REVA University	**Member (Internal)**	Dr. Hemanth K Associate Professor, School of Mechanical Engineering , REVA University, Bengaluru 560064
10	**Dr. Niranjan C Hiremath** Associate Professor and PG Coordinator, School of ME, REVA University	**Member (Internal)**	Dr. Niranjan C Hiremath Associate Professor, School of Mechanical Engineering , REVA University, Bengaluru 560064
11	**Ms. Rashmi B Ugargol** Senior Design Engineer, Collins Aerospace Ltd.	**Member Alumini**	Ms. Rashmi B Ugargol Senior Design Engineer, Collins Aerospace Ltd, Bengaluru

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 72 credits spread across four semesters to obtain the M.Tech degree. These credits are split into Foundation Core (FC), Hard Core (HC), Soft Core (SC) and online courses.

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. All theory subjects integrated with practical component.
4. Long term internship leading to placements.
5. Opportunity to pursue MOOC course as per interest.
6. 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 (PEO's)

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

- **PEO-1:** Be machine designers to design mechanical equipment, machines and mechanical systems as per the desired customer specifications.
- **PEO-2:** Pursue doctoral research degree to work in colleges, universities as professors or as scientists in research establishments.
- **PEO-3:** Act as administrators in public, private and government organizations or business administrator or entrepreneur after further training.

Program Outcomes (POs)

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

- **PO-1: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.
- **PO-2: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.
- **PO-3: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.
- **PO-4: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.
- **PO-5: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.
- **PO-6:** 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.
- **PO-7:** 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.
- **PO-8: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.

- **PO-9:** 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.

- **PO-10:** 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.

- **PO-11:** 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).**

Programme Specific Outcomes (PSO's)

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.

Regulations – M Tech., Degree Program
Academic Year 2020-21 Batch

(Framed as per the provisions under Section 35 (ii), Section 7 (x) and Section 8 (xvi) & (xxi) of the REVA University Act, 2012)

1. Title and Commencement:

1.1 These Regulations shall be called **"REVA University Academic Regulations – M Tech., Degree Program 2020-21 Batch subject to amendments from time to time by the Academic Council on recommendation of respective Board of Studies and approval of Board of Management**

1.2 These Regulations shall come into force from the date of assent of the Chancellor.

2. The Programs:

These regulations cover the following M Tech., Degree programs of REVA University offered during 2020-21

M Tech (Full Time) in:
Artificial Intelligence
Computer Science and Engineering
Computer Aided Structural Engineering
Construction Technology & Management
Digital Communication and Networking
Machine Design
Power Energy & Systems
Transportation Engineering and Management
VLSI and Embedded Systems

Also
M Tech (Part Time) in:
Computer Science and Engineering
VLSI and Embedded Systems

3. Duration and Medium of Instructions:

3.1 **Duration:** The duration of theM Tech degree program shall be **TWO years** comprising of **FOUR** Semesters. A candidate can avail a maximum of 8 semesters - 4 years as per double duration norm, in one stretch to complete M Tech degree. The duration for part time students is **THREE years** and a maximum of 6 years they are required to complete the program.

3.2 The medium of instruction shall be English.

4. Definitions:

4.1 Course: "Course" means a subject, either theory or practical or both, listed under a programme; Example: "Finite Element Method of Analysis" in M Tech Civil Engineering program, "Advanced Theory of Vibration" in M Tech., Mechanical program are examples of courses to be studied under respective programs.

Every course offered will have three components associated with the teaching-learning process of the course, namely:

L	**Lecture**
T	**Tutorial**
P	**Practice**

Where:

L stands for **Lecture** session consisting of classroom instruction.

T stands for **Tutorial** session consisting participatory discussion / self-study/ desk work/ brief seminar presentations by students and such other novel methods that make a student to absorb and assimilate more effectively the contents delivered in the Lecture classes.

P stands for **Practice** session and it consists of Hands on Experience / Laboratory Experiments / Field Studies / Case Studies / Project Based Learning or Course end Project/Self Study/ Online courses from listed portals that equip students to acquire the much required skill component.

4.2 Classification of Courses

Courses offered are classified as: Core Courses, Open Elective Courses, Project work/Dissertation

4.2.1 **Core Course:** A course which should compulsorily be studied by a candidate choosing a particular program of study

4.2.2 **Foundation Course:** The foundation Course is a mandatory course which should be completed successfully as a part of graduate degree program irrespective of the program of study

4.2.3 **Hard Core Course (HC) simply core course:** The **Hard Core Course** is a Core Course in the main branch of study and related branch(es) of study, if any, that the candidates have to complete compulsorily

4.2.4 **Soft Core Course (SC) (also known as Professional Elective Course)**

A Core course may be a **Soft Core** if there is a choice or an option for the candidate to choose a course from a pool of courses from the main branch of study or from a sister/related branch of study which supports the main branch of study

4.2.5 **Open Elective Course (OE):**

An elective course chosen generally from other discipline / subject, with an intention to seek exposure to the basics of subjects other than the main discipline the student is studying is called an **Open Elective Course**

4.2.6 **Project Work / Dissertation:**

Project work / Dissertation work is a special course involving application of knowledge in solving / analysing /exploring a real life situation / difficult problems to solve a multivariable or complex engineering problems.

5. Eligibility for Admission:

5.1. The eligibility criteria for admission to M Tech Program (Full Time) of 2 years (4 Semesters) and (Part Time) of 3 years (6 Semesters) are given below:

Sl. No.	Program	Duration	Eligibility
1	Masters of Technology (M Tech) in Artificial Intelligence	4 Semesters (2 years)	B E / B.Tech. in CSE / ISE / TE / MCA / M. Sc. in Computer Science or Mathematics or Information Science or Information Technology with a minimum of 50% (45% in case of SC/ST) marks in aggregate of any recognized University / Institution or AMIE or any other qualification recognized as equivalent there to.

2	M Tech in Computer Science and Engineering	**Full Time** – 4 Semesters (2 years) **Part Time** – 6 Semesters (3 years)	B E / B.Tech. in ECE / IT / EEE / CSE / ISE / TE / MCA / M.Sc. in Computer Science or Mathematics or Information Science or Information Technology with a minimum of 50% (45% in case of SC/ST) marks in aggregate of any recognized University / Institution or AMIE or any other qualification recognized as equivalent there to.
3	M Tech in Computer Aided Structural Engineering Construction Technology & Management Transportation Engineering and Management	4 Semesters (2 years)	BE/ B.Tech. in Civil Engineering with a minimum of 50% (45% in case of SC/ST) marks in aggregate of any recognized University / Institution or AMIE or any other qualification recognized as equivalent there to.
4	M Tech in Power Energy & Systems	4 Semesters (2 years)	BE/ B.Tech. in EE/ EEE/ ECE/ CSE/ MS / M.Sc. in Mathematics/Physics/Electronics / Information Technology or Information Science with a minimum of 50% (45% in case of SC/ST) marks in aggregate of any recognized University / Institution or AMIE or any other qualification recognized as equivalent there to.
5	M Tech in Digital Communication and Networking Machine Design	4 Semesters (2 years)	B E / B.Tech. in ECE /TE / EEE / CSE / ISE / Instrumentation Technology / Medical Electronics/M Sc in Electronics with a minimum of 50% (45% in case of SC/ST) marks in aggregate of any recognized University/Institution or AMIE or any other qualification recognized as equivalent there to.
6	M Tech in VLSI and Embedded Systems	**Full Time** – 4 Semesters (2 years) **Part Time** – 6 Semesters (3 years)	B E / B.Tech. in ECE /TE / EEE / CSE / ISE / Instrumentation Technology / Medical Electronics/M Sc in Electronics with a minimum of 50% (45% in case of SC/ST) marks in aggregate of any recognized University/Institution or AMIE or any other qualification recognized as equivalent there to.
7	M Tech in Machine Design	4 Semesters (2 years)	BE / B.Tech. in Mechanical/Aeronautical / Automobile / Industrial Production Engineering with a minimum of 50% (45% in case of candidatebelonging to SC/ST category) marks in aggregate, of any recognized University / Institution or AMIE or any other qualification recognized as equivalent there to.

5.2 Provided further that the eligibility criteria are subject to revision by the Government Statutory Bodies, such as AICTE, UGC from time to time.

6. Courses of Study and Credits

6.1 Each course of study is assigned with certain credit value

6.2 Each semester is for a total duration of 20 weeks out of which 16 weeks dedicated for teaching and learning and the remaining 4 weeks for final examination, evaluation and announcement of results

6.3 The credit hours defined as below

In terms of credits, every one hour session of L amounts to 1 credit per Semester and a minimum of two hour session of T or P amounts to 1 credit per Semester or a three hour session of T / P amounts to 2 credits over a period of one Semester of 16 weeks for teaching-learning process.

1 credit = 13 credit hours spread over 16 weeks or spread over the semester

The total duration of a semester is 20 weeks inclusive of semester-end examination.

The following table describes credit pattern

Table-2: CreditPattern

Lectures(L)	Tutorials(T)	Practice (P)	Credits(L:T:P)	Total Credits	TotalContact Hours
4	2	0	4:1:0	5	6
3	2	0	3:1:0	4	5
3	0	2	3:0:1	4	5
2	2	2	2:1:1	4	6
0	0	6	0:0:3	3	6
4	0	0	4:0:0	4	4
2	0	0	2:0:0	2	2

a. The concerned BoS will choose the convenient Credit Pattern for every course based on size and nature of the course

7. Different C**ourses of Study**:

Different C**ourses of Study** are labeled as follows:

a. Core Course (CC)
b. Foundation Course (FC)

c. Hard Core Course (HC)
d. Soft Core Course (SC)
e. Open Elective Course (OE)
f. Minor Project
g. Major Project / Dissertation:

The credits for minor projects, major project/Dissertation will be decided by the respective Schools.

8. Credit and Credit Distributions:

8.1 A candidate has to earn 72 credits for successful completion of M Tech degree with a distribution of credits for different courses as prescribed by the University.

8.2 A candidate can enroll for a maximum of 24 credits per Semester. However s/he may not successfully earn a maximum of 24 credits per semester. This maximum of 24 credits does not include the credits of courses carried forward by a candidate.

8.3 **Only such full time candidates who register for a minimum prescribed number of credits in each semester from I semester to IV semester and complete successfully 72 credits in 4 successive semesters shall be considered for declaration of Ranks, Medals, Prizes and are eligible to apply for Student Fellowship, Scholarship, Free ships, and such other rewards / advantages which could be applicable for all full time students and for hostel facilities**.

9. Assessment and Evaluation

9.1 The assessment and evaluation process happens in a continuous mode. However, for reporting purpose, a Semester is divided into 3 components as IA1, IA2 and SEE. The performance of a candidate in a course will be assessed for a maximum of 100 marks as explained below.

(i) Component IA1:

The first Component (IA1), of assessment is for 25 marks. This will be based on test, assignment / seminar. During the first half of the semester (i.e. by 8th week), the first 50% of the syllabus (Unit 1&2) will be completed. This shall be consolidated during the first three days of 8th week of the semester. A review test based on IA1 will be conducted and completed in the beginning of the 9th week. In case of courses where test cannot be conducted, the form of assessment will be decided by the concerned school and such formalities of assessment will be completed in the beginning of the 9th week. The

academic sessions will continue for IA2 immediately after completion of process of IA1.

The finer split - up for the award of marks in IA1 is as follows:

Assignment & Seminars…….. 10 marks for the first 20% of the syllabus

Test (Mid-Term) ……..15 marks for the first 30% of the syllabus

Total …… ……..25 marks

(ii) Component IA2:

The second component (IA2), of assessment is for 25 marks. This will be based on test, assignment /seminar. The continuous assessment and scores of second half of the semester (9th to 16th week) will be consolidated during 16th week of the semester. During the second half of the semester the remaining units in the course will be completed. A review test based on IA2 will be conducted and completed during 16th week of the semester. In case of courses where test cannot be conducted, the form of assessment will be decided by the concerned school and such formalities of assessment will be completed during 16th week.

The 17th week will be for revision of syllabus and preparation for the semester – end examination.

The finer split - up for the award of marks in IA2 is as follows:

Assignment/Seminar……..10 marks for the second 20% of the syllabus

Review Test (Mid-Term) ……..15 marks for the second 30% of the syllabus

Total ……..25 marks

(iii) Component SEE:

The Semester End Examination of 3 hours duration for each course shall be conducted during the 18th & 19th week. **This forms the third / final component of assessment (SEE) and the maximum marks for the final component will be 50.**

9.2 The schedule of continuous assessment and examinations are summarized in the following table below.

Component	Period	Syllabus	Weightage	Activity
IA1	1st Week to 8th Week	First 50% (two units)		Instructional process and Continuous Assessment

	Last 3 days of 8th Week		25%	Consolidation of IA1
IA2	9th week to 16th week	Second 50% (remaining two units)		Instructional process and Continuous Assessment
	Last 3 days of 16th week		25%	Consolidation of IA2
SEE	17th and 18th week			Revision and preparation for Semester end examination
	19th week to 20th week	Entire syllabus	50%	Conduct of semester end examination and Evaluation concurrently
	21st week			Notification of Final Grades
***Evaluation shall begin very first day after completion of the conduct of examination of the first course and both examination and evaluation shall continue concurrently. The examination results / final grades be announced latest by 21st week**				

Note: 1. Practical examination wherever applicable shall be conducted before conducting of IA2 examination. The calendar of practical examination shall be decided by the respective school.

2. Finally**, awarding the Grades** be announced latest by 5 days after completion of the examination.

9.3 The Assessment of MOOC and Online Courses shall be decided by the concerned School Board of Studies (BOS).

9.3.1**For> 3 credit courses**

i	IA-I	25 marks
ii	IA-2	25 marks
iii	Semester end examination by the concern school board (demo, test, viva voice etc)	50 marks
	Total	**100 marks**

9.3.2 **For 1 & 2 credit courses**

i	IA-I	15 marks
ii	IA-2	15 marks
iii	Semester end examination by the concern school board (demo, test, viva voice etc)	20 marks
	Total	**50 marks**

9.3.3 The 50 marks meant for Internal Assessment (IA) of the performance in carrying out practical shall further be allocated as under:

i	Conduction of regular practical / experiments throughout the semester	20 marks
ii	Maintenance of lab records / Activities /Models / charts etc	10 marks
iii	Performance of mid-term test (to be conducted while conducting second test for theory courses); the performance assessments of the mid-term test includes performance in the	20 marks

	conduction of experiment and write up about the experiment.	
	Total	**50 marks**

In case of an integrated course 20% marks be earmarked for laboratory work.

For example:

During IA1

Laboratory work …….…….. 10 marks

Test (Mid-Term) ……..15 marks for the first 50% of the theory syllabus

Total …… ……..25 marks

During IA2

Laboratory work …….…….. 10 marks

Test (Mid-Term) ……..15 marks for the second 50% of theory syllabus

Total …… ……..25 marks

SEE to be conducted for theory portions only and assessed for 50 marks

10. Setting Questions Papers and Evaluation of Answer Scripts:

10.1 There shall be three sets of questions papers set for each course. Two sets of question papers shall be set by the internal and one set by external examiner for a course. The Chairperson of the BoE shall get the question papers set by internal and external examiners.

10.2 The Board of Examiners shall scrutinize and approve the question papers and scheme of valuation.

10.3 There shall be double evaluation, viz, first valuation by the internal evaluator who has taught the course and second evaluation shall be an external examiner who is familiar with the course. The average marks of the two evaluations (internal examiner & external examiner) shall be the marks to be considered for declaration of results.

10.4 The examination for Practical work/ Field work/Project work will be conducted jointly by two examiners (internal and external). However, in case of non-availability of external examiner or vice versa, the Chairperson BoE at his discretion can invite internal / external examiners as the case may be, if required.

10.5 If a course is fully of (L=0):T: (P=0) type, then the examination for SEE Component will be as decided by the BoS concerned.

10.6 In case of a course with only practical component a practical examination will be conducted with two examiners and each candidate will be assessed on the basis of: a) Knowledge of relevant processes, b) Skills and operations involved, and c) Results / Products including calculation and reporting.

10.7 The duration for Semester-End practical examination shall be decided by the Controller of Examinations.

11. Evaluation of Minor Project / Major Project / Dissertation:

Right from the initial stage of defining the problem, the candidate has to submit the progress reports periodically and also present his/her progress in the form of seminars in addition to the regular discussion with the supervisor. At the end of the semester, the candidate has to submit final report of the project / dissertation, as the case may be, for final evaluation. The components of evaluation are as follows:

Component – I	(IA1)	Periodic Progress and Progress Reports (25%)
Component – II	(IA2)	Results of Work and Draft Report (25%)
Component– III	(SEE)	Final Evaluation and Viva-Voce (50%). Evaluation of the report is for 30% and the Viva-Voce examination is for 20%.

12. All assessments must be done by the respective Schools as per the guidelines issued by the Controller of Examinations. However, the responsibility of announcing final examination results and issuing official transcripts to the students lies with the office of the Controller of Examinations.

13. Requirements to Pass a Course

13.1 A candidate's performance from all 3 components will be in terms of scores, and the sum of all three scores will be for a maximum of 100 marks (25 + 25 + 50). A candidate who secures a minimum of 40% in the SEE and an overall 40% (IA1+IA2+SEE) in a course is said to be successful.

13.2 **The Grade and the Grade Point:** The Grade and the Grade Point earned by the candidate in the subject will be as given below:

Marks, P	Grade, G	Grade Point (GP=V x G)	Letter Grade
90-100	10	v*10	O
80-89	9	v*9	A+
70-79	8	v*8	A
60-69	7	v*7	B+
55-59	6	v*6	B
50-54	5.5	v*5.5	C+
40-49	5	v*5	C
0-39	0	v*0	F
ABSENT			AB

O - Outstanding; A+-Excellent; A-Very Good; B+-Good; B-Above Average; C+-Average; C-Satisfactory; F – Unsatisfactory.

Here, P is the percentage of marks (P=[(IA1+IA2)+SEE] secured by a candidate in a course which is **rounded to nearest integer**. v is the credit value of course. G is the grade and GP is the grade point.

a. Computation of SGPA and CGPA

The Following procedure to compute the Semester Grade Point Average (SGPA)

The SGPA is the ratio of sum of the product of the number of credits with the grade points scored by a student in all the courses taken by a student and the sum of the number of credits of all the courses undergone by a student, i.e

SGPA (Si) = ∑(Ci x Gi) / ∑Ci

Where Ci is the number of credits of the ith course and Gi is the grade point scored by the student in the ith course.

b. Illustration for Computation of SGPA and CGPA

Illustration No. 1

Course	Credit	Grade letter	Grade Point	Credit Point (Credit x Grade)
Course 1	**3**	**A**	**9**	**3X9=27**
Course 2	**3**	**B**	**8**	**3X8=24**
Course 3	**3**	**C**	**7**	**3X7=21**
Course 4	**3**	**O**	**10**	**3X10=30**

Course 5	**3**	**D**	**6**	**3X6=18**
Course 6	**3**	**O**	**10**	**3X10=30**
Course 7	**2**	**A**	**9**	**2X 9 = 18**
Course 8	**2**	**B**	**8**	**2X 8 = 16**
	22			**184**

Thus, **SGPA = 184 ÷ 22 = 8.36**

c. Cumulative Grade Point Average (CGPA):

Overall Cumulative Grade Point Average (CGPA) of a candidate after successful completion of the required number of credits (72) for two year post graduate degree in a specialization is calculated taking into account all the courses undergone by a student over all the semesters of a program, i. e

CGPA = ∑(Ci x Si) / ∑Ci

Where Si is the SGPA of the ith semester and Ci is the total number of credits in that semester.

The SGPA and CGPA shall be rounded off to 2 decimal points and reported in the transcripts.

Illustration:

CGPA after Final Semester

Semester (ith)	**No. of Credits (Ci)**	**SGPA (Si)**	**Credits x SGPA (Ci X Si)**
1	22	8.36	22 x 8.36 = 183.92
2	22	8.54	22 x 8.54 =187.88
3	16	9.35	16x9.35=149.6
4	12	9.50	12x9.50=114
Cumulative	**72**		635.4

Thus, **CGPA** = $\frac{22x8.36+22x8.54+16x9.35+12x9.50}{72}$ = 8.83

13.3 **Conversion of Grades into Percentage:**

Conversion formula for the conversion of CGPA into Percentage is:

Percentage of marks scored = CGPA Earned x 10

Illustration: CGPA Earned 8.83 x 10=88.30

14. Classification of Results

The final grade point (FGP) to be awarded to the student is based on CGPA secured by the candidate and is given as follows:

CGPA	Grade (Numerical Index)	Letter Grade	Performance	FGP
	G			Qualitative Index
9 >= CGPA 10	10	O	Outstanding	Distinction
8 >= CGPA < 9	9	A+	Excellent	
7 >= CGPA < 8	8	A	Very Good	First Class
6 >= CGPA < 7	7	B+	Good	
5.5> = CGPA < 6	6	B	Above average	Second Class
> 5 CGPA < 5.5	5.5	C+	Average	
> 4 CGPA <5	5	C	Satisfactory	Pass
< 4 CGPA	0	F	Unsatisfactory	Unsuccessful

Overall percentage=10*CGPA

a. **Provisional Grade Card:** The tentative / provisional Grade Card will be issued by the Controller of Examinations at the end of every Semester indicating the courses completed successfully. The provisional grade card provides **Semester Grade Point Average** (SGPA).This statement will not contain the list of DROPPED courses.

b. **Final Grade Card:** Upon successful completion of the Post Graduate Degree a Final Grade card consisting of grades of all courses successfully completed by the Candidate will be issued by the COE.

15. Attendance Requirement:

15.1 All students must attend every lecture, tutorial and practical classes.

15.2 In case a student is on approved leave of absence (e g:- representing the University in sports, games or athletics, placement activities, NCC, NSS activities and such others) and / or any other such contingencies like medical emergencies, the attendance requirement shall be minimum of 75% of the classes taught.

15.3 Any student with less than 75% of attendance in aggregate of all the courses including practical courses / field visits etc., during a semester shall not be permitted to appear to the end semester examination and such student shall seek re-admission

16. Re-Registration and Re-Admission:

16.1 In case a candidate's class attendance in aggregate of all courses in a semester is less than 75% or as stipulated by the University, such a candidate is considered as dropped the semester and is not allowed to appear for semester end examination and he / she shall have to seek re-admission to that semester during subsequent semester / year within a stipulated period.

16.2 In such case where in a candidate drops all the courses in a semester due to personal reasons, it is considered that the candidate has dropped the semester and he / she shall seek re-admission to such dropped semester.

17. **Absence during Internal Test:**

In case a student has been absent from an internal tests due to the illness or other contingencies he / she may give a request along with necessary supporting documents and certification from the concerned class teacher / authorized personnel to the concerned Director of the School, for conducting a separate internal test. The Director of the School may consider such request depending on the merit of the case and after consultation with course instructor and class teacher, and arrange to conduct a special internal test for such candidate(s) well in advance before the Semester End Examination of that respective semester. Under no circumstances internal tests shall be held / assignments are accepted after Semester End Examination.

18. **Eligibility to Appear for Semester End Examination (SEE)**

18.1 Only those students who fulfill 75% attendance requirement and who secure minimum 30% marks in IA1 and IA2 together in a course are eligible to appear for SEE examination in that course.

18.2 Those students who have 75% of attendance but have secured less than 30% marks in IA1 and IA2 together in a course are not eligible to appear for SEE examination in that course. They are treated as dropped the course and they will have to repeat that course whenever it is offered.

18.3 In case a candidate secures more than 30% in IA1 and IA2 together but less than 40% in aggregate of IA1, IA2 and SEE in a course is considered as unsuccessful and such a candidate may either opt to DROP that course or appear for SEE examination during the subsequent semesters / years within the stipulated period.

18.4 In such a case wherein he / she opts to appear for just SEE examination, then the marks secured in IA1 and IA2 shall get continued. Repeat SEE examination will be conducted in respective semesters.

19. **Provision for Supplementary Examination**

In case a candidate fails to secure a minimum of 40% (20 marks) in Semester End Examination (SEE) and a minimum of 40% marks overall (IA and SEE together), such candidate shall seek supplementary examination of only such course(s) wherein his / her performance is declared unsuccessful. The supplementary examinations are conducted after the announcement of even semester examination results. The candidate who is unsuccessful in a given course(s) shall appear for supplementary examination of odd and even semester course(s) to seek for improvement of the performance.

20. **Provision to Carry Forward the Failed Subjects / Courses:**

A candidate who secures a minimum of 40% in the SEE and an overall 40% (IA1+IA2+SEE) in a course is said to be successful otherwise considered that the candidate has failed the course. A candidate is required to successfully complete all the courses before submission of major project report or dissertation report.

(It means that the candidate has no restrictions on the number of courses that can be carried forward)

21. **Provision for Appeal**

If a candidate is not satisfied with the evaluation of Internal Assessment components (Internal Tests and Assignments), he/she can approach the Grievance Cell with the written submission together with all facts, the assignments, and test papers, which were evaluated. He/she can do so before the commencement of respective semester-end examination. The Grievance Cell is empowered to revise the marks if the case is genuine and is also empowered to levy penalty as prescribed by the University on the candidate if his/her submission is found to be baseless and unduly motivated. This Cell may recommend for taking disciplinary/corrective action on an evaluator if he/she is found guilty. The decision taken by the Grievance committee is final.

22. **Grievance Committee:**

In case of students having any grievances regarding the conduct of examination, evaluation and announcement of results, such students can approach Grievance Committee for redressal of grievances. Grievance committees will be formed by CoE in consultation with VC

For every program there will be one grievance committee. The composition of the grievance committee is as follows:-

- The Controller of Examinations - Ex-officio Chairman / Convener
- One Senior Faculty Member (other than those concerned with the evaluation of the course concerned) drawn from the school / department/discipline and/or from the sister schools / departments/sister disciplines – Member.
- One Senior Faculty Members / Subject Experts drawn from outside the University school / department – Member.

23. With regard to any specific case of ambiguity and unsolved problem, the decision of the Vice-Chancellor shall be final.

M. Tech. in Machine Design

Scheme of Instructions

I SEMESTER

Sl. No	Course Code	Title of the Course	HC/ SC/ OE	Pre requisite	Credit Pattern & Credit Value				Contact Hours/ Week
					L	T	P	Total	
1	M20AS0103	Computational Methods in Engineering	HC	B.Tech. in Mechanical and allied branches	2	0	1	3	4
2	M20TI0101	Advanced Mechanical Vibrations	HC	B.Tech. in Mechanical and allied branches	4	0	0	4	4
3	M20TI0102	Advanced Mechanics of Materials	HC	B.Tech. in Mechanical and allied branches	2	1	0	3	3
4	M20TI0103	Computer Aided Engineering	HC	B.Tech. in Mechanical and allied branches	2	0	1	3	4
5	M20TIS111	Design of Experiments	SC-1	B.Tech. in Mechanical and allied branches	3	0	1	4	5
					3	0	1	4	5
	M20TIS112	Synthesis and Analysis of Mechanisms			3	0	1	4	5
TOTAL					**13**	**1**	**3**	**17**	**20**
	Practical /Term Work / Practice Sessions/Online /MOOC								
6	M20TI0104	Design Thinking	HC	B.Tech. in Mechanical and allied branches	2	0	1	3	4
				TOTAL	**2**	**0**	**1**	**3**	**4**
								TOTAL SEMESTER CREDITS	**20**
								TOTAL CUMULATIVE CREDITS	**20**
								TOTAL CONTACT HOURS	**24**

II SEMESTER

Sl. No	Course Code	Title of the Course	HC/SC / OE	Pre requisite	Credit Pattern & Credit Value				Contact Hours/ Week
					L	T	P	Total	
1	M20TI0201	Advanced Engineering Materials	HC	-	2	0	1	3	4
2	M20TI0202	Advanced Finite Element Methods	HC	M20TI0101 M20AS0103	3	0	1	4	5
3	M20TI0203	Design for Manufacture, Assembly and Environment	HC	-	4	0	0	4	4
4	M20TI0204	Project Management	HC	-	2	0	1	3	4
5	M20TIS211	Mechatronics Product Design	SC-2	M20TI0101	2	0	1	3	4
	M20TIS212	Vehicle Dynamics							
6	M20TIS221	Additive Manufacturing	SC-3	-	3	0	0	3	3
	M20TIS222	Computational Fluid Dynamics							
	M20TIS223	Robotics and its Applications							
TOTAL					**16**	**0**	**4**	**20**	**24**
TOTAL SEMESTER CREDITS								**20**	
TOTAL CUMULATIVE CREDITS								**40**	
TOTAL CONTACT HOURS								**24**	

III SEMESTER

Sl.	Course Code	Title of the	HC/SC/	Credit Pattern & Credit Value	Contact

No		Course	OE	L	T	P	Total	Hours/ Week
1	M20TI0301	Industrial Internship	HC	0	0	8	8	16
2	M20TI0302	Project Dissertation Phase-I	HC	0	0	4	4	8
3	M20TIO301	*MOOC/SWAYAM On line Course of Interdisciplinary Nature	OE	4	0	0	4	4
			Total	**8**	**0**	**8**	**16**	**28**
						TOTAL SEMESTER CREDITS		**16**
						TOTAL CUMULATIVE CREDITS		**56**
						TOTAL CONTACT HOURS		**28**

* List of online courses will be provided to students depending on availability of courses during their 3rd semester.

IV SEMESTER

Sl. No	Course Code	Title of the Course	HC/ SC/ OE	Pre requisite	Credit Pattern & Credit Value				Contact Hours/ Week
					L	T	P	Total	
	Practical /Term Work / Practice Sessions/Online /MOOC								
1	M20TI0401	Master Thesis	HC	-	0	0	16	16	32
				TOTAL	**0**	**0**	**16**	**16**	**32**
							TOTAL SEMESTER CREDITS		**16**
							TOTAL CUMULATIVE CREDITS		**72**
							TOTAL CONTACT HOURS		**32**

Detailed Syllabus

Semester - 1

M20AS0103	Computational Methods in Engineering	HC	L	T	P	C	Hrs /week
Duration:14 Wks			2	0	1	3	4

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 successful completion of the course, the students 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.

BLOOM'S LEVELOF THECOURSE OUTCOMES

CO	Bloom'sLevel					
	Remember (L1)	Understand (L2)	Apply (L3)	Analyze (L4)	Evaluate (L5)	Create (L6)
CO1	✓					
CO2					✓	
CO3			✓			
CO4				✓		

Mapping of Course Outcomes with Programme Outcomes

Course Code	POS/ COs	PO 1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PS O1	PS O2	PS O3
M20AS0103	CO1	3	3	1	1	2	-	-	2	-	-	-	3	3	
	CO2	2	3	1	1	2	-	-	2	-	-	-	3	3	
	CO3	3	3	1	1	2	-	-	2	-	-	-	3	3	
	CO4	3	3	1	1	2	-	-	2	-	-	-	3	3	2

Course Contents:

Unit: 1Introduction to Numerical Methods & Numerical Integration

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.

Lab Component: Solving linear and non-linear equations using MATLAB commands

Unit: 2Optimization

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.

Unit: 3 Numerical solutions of partial differential equations

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.

Lab Component:Solving partial and ordinary differential equations using MATLAB commands(PDE23 & ODE45)

Unit: 4 Hyperbolic partial differential equations & Curve fitting

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

Lab Component: Exercises on curve fitting using MATLAB commands

TEXT BOOKS:

1. Steven C.Chapra, Raymond P.Canale, "Numerical Methods for Engineers", Tata Mc-Graw Hill, 3rd Edition, 2000.
2. Curtis F.Gerald, Partick.O.Wheatly, "Applied numerical analysis", Addison-wesley, 2nd Edition, 1989.
3. Douglas J.Faires, RichedBurden,"Numerical methods", Brooks/cole publishing company, 4th Edition, 1998.

REFERENCES:

1. Ward Cheney & David Kincaid, "Numerical mathematics and computing" Brooks / Cole publishing Company, 4thEdition 1999.
2. Riley K.F.M.P.Hobson&Bence S.J, "Mathematical methods for physics and engineering" ,Cambridge university press, 2nd Edition,1999.

M20TI0101	Advanced Mechanical Vibrations	HC	L	T	P	C	Hrs /week
Duration:14 Wks			4	0	0	4	5

Prerequisites:

Prerequisite: Engg Mathematics, Mechanical Vibrations

Course Objectives:

1. To enable the students to understand response to periodic and non-periodic excitations.
2. To teach students about non linear Vibration.
3. To enable students to solve free vibration of spring - coupled systems under 2DoFs
4. To apply modal analysis to forced vibrations using matrix inversion for MDOF systems.
5. To understand the importance of condition monitoring techniques.
6. To apply SPM and AE techniques in analyzing machine failures

Course Outcomes:

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

1 Solve 1 DoF and 2 DoF Vibration problems.
2 Apply vibration principles to solve continuous problems.
3 Analyze nonlinear and random vibration problems.
4 Apply SPM and AE methods to identify machine failures.

BLOOM'S LEVELOF THECOURSE OUTCOMES:

CO	Bloom'sLevel					
	Remember (L1)	Understand (L2)	Apply (L3)	Analyze (L4)	Evaluate (L5)	Create (L6)
CO1					✓	
CO2			✓			
CO3				✓		
CO4			✓			

Mapping of Course Outcomes with Programme Outcomes

Course Code	POS/ Cos	PO1	PO2	PO3	PO4	PO5	PO6	P07	PO8	PO9	PO 10	PO 11	PS O1	PS O2	PS O3
M20TI0101	CO1	3	2	2	1	-	-	-	2	-	-	-	3	3	2
	CO2	3	3	3	-	-	-	-	2	-	-	-	3	2	2
	CO3	3	2	2	1	-	-	-	2	-	-	-	2	2	2
	CO4	3	2	2	-	-	-	-	2	-	-	-	3	2	1

Course Contents:

Unit:1 **Review of Fundamentals of vibration and 2 DOF systems**

Introduction to basic vibration, Review of Single degree freedom system- Response to periodic excitations, free vibration with viscous damping, forced vibration due to harmonic excitation, transmissibility. Determination of Natural frequency of Two- degree freedom system.

Unit:2 **Vibration of Continuous systems**

Introduction to Vibration of Continuous systems- Vibration analysis of strings, Longitudinal vibration of bar or rod, Transverse vibration of rod, Vibration of beams by Euler's equation-Effect of rotary inertia and shear deformation effects-Effect of axial force and different types of problems.

Unit:3 **Random and Non-linear vibration**

Introduction to Random Vibration: Probability density function, Stationary and ergodic process- Auto-correlation function- Power spectral density-Narrow band and wideband random processes, Response of single -DOF systems.

Introduction to non-linear vibration- Fundamental concepts in stability and equilibrium points- Perturbation technique, Phenomena of Jump, vibration analysis of a simple pendulum with non-linear behavior Contemporary Discussion

Unit:4 **Condition Monitoring and fault diagnosis by vibration signal**

Introduction to Condition monitoring- Machine maintenance technique, Machine condition monitoring techniques, Machine fault signature analysis, signal analysis. Introduction to vibration Monitoring technique - vibration data collection, techniques, instruments, transducers, selection, vibration measurement, time domain analysis, frequency domain analysis and different case studies.

TEXT BOOKS: 1. S. S. Rao, "Mechanical Vibrations", Pearson Education Inc, 4th edition, 2003.
2.V. P. Singh, "Mechanical Vibrations", Dhanpat Rai & Company, 3rd edition, 2006.
3. R. A. Caollacatt, Chapman, "Mechanical Fault Diagnosis and Condition Monitoring", Chapman and hall ,1st Edition,1977

REFERENCES: 1. G. K.Grover, "Mechanical Vibrations", Nem Chand and Bros, 6th edition, 1996.
2. W. T. Thomson, M. D. Dahleh and C. Padmanabhan, "Theory of Vibration with Applications", Pearson Education Inc, 5th edition, 2008.
3. S. Graham Kelly, "Mechanical Vibrations", Schaum's outline Series, Tata McGraw Hill, Special Indian Edition, 2007.

M20TI0102	Advanced Mechanics of Materials	HC	L	T	P	C	Hrs /week
Duration:14 Wks			2	1	0	3	3

Prerequisites:

Engg. Mathematics, Material Science & Metallurgy, Mechanics of Materials.

Course Objectives:

1. To enable the students to understand equilibrium equation for elastic body and to obtain stress-strain components for the elastic component.
2. Provide systematic basic knowledge for and Cubical Dilation, Uniqueness Theorem
3. Provide systematic basic knowledge of Plastic Stress Strain Relations and Yield Criteria
4. To enable the students to understand Fundamental Concepts and Elastic-Plastic Fracture Mechanics

Course Outcomes:

1 Explain the fundamentals of equilibrium equation and analyze the Stress and Strain.
2 Formulate Cubical Dilation and Uniqueness Theorem
3 Formulate the Plastic Stress Strain Relations and Yield Criteria
4 Derive Fundamental equations related to Elastic-Plastic Fracture Mechanics

BLOOM'S LEVELOF THECOURSE OUTCOMES:

CO	Bloom'sLevel					
	Remember (L1)	Understand (L2)	Apply (L3)	Analyze (L4)	Evaluate (L5)	Create (L6)
CO1	✓					
CO2				✓		
CO3				✓		
CO4					✓	

Mapping of Course Outcomes with Programme Outcomes

Course Code	POS/ COs	PO1	PO2	PO3	PO4	PO5	PO6	P07	PO8	PO9	PO 10	PO 11	PSO1	PSO2	PSO3
M20TI0102	CO1	3	2	1					2				1	3	
	CO2	2	2	3					2				3	2	1
	CO3	2	2	3					2				3	2	1
	CO4	2	2	3					2				3	2	

Course Contents:

Unit:1 **Analysis of Stress-Strain Relation**

Analysis of Stress: Stress, Stress at a Point, Equilibrium Equations, Principal Stresses, Mohr's Diagram, Maximum Shear Stress, Boundary Conditions.

Analysis of Strain: Compatibility Equations, Principal Strains, Generalized Hooke's law, Methods of Solution of Elasticity Problems – Plane Stress- Plane Strain Problems.

Unit:2 **Cubical Dilation and Uniqueness Theorem**

Cubical Dilation, True Stress and Strain: Strain tensor, principal strain, plane strain, spherical and deviator strain, octahedral strain and representative strain, problems

Uniqueness Theorem: Principle of super position, reciprocal theorem, saint venant's principle

Unit:3 **Plastic Stress Strain Relations and Yield Criteria**

Plastic Stress Strain Relations: Introduction, types of materials, empirical equations, theories of plastic flow, experimental verification of St.Venant's theory of plastic flow.

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.

Unit:4: **Fundamental Concepts and Elastic-Plastic Fracture Mechanics**

Fundamental Concepts: Introduction, Linear Elastic Fracture Mechanics, An Atomic View of Fracture, Stress Concentration Effect of Flaws, The Griffith Energy Balance, The Energy Release Rate, Stress Analysis of Cracks, Relationship between K and G, Crack-Tip Plasticity.

Elastic-Plastic Fracture Mechanics: Crack-Tip-Opening Displacement, The J Contour integral, Crack-Growth Resistance Curves.

TEXT BOOKS:

1. L. S. Srinath, "Mechanics of solids", Tata McGraw Hill, 3rd Edition, 2008.
2. S. P. Timoshenko and J. N Gordier, "Theory of Elasticity", Mc.GrawHill International, 3rd edition, 1972.
3. Chakraborty,"Theory of Plasticity", Elsevier, 3rd Edition 2000.
4. W. Johnson and P. B. Mellor, "Engineering Plasticity", D Van N.O Strand Co. Ltd, 2000.

REFERENCES:

1. Dr. Sadhu Singh, "Theory of Elasticity", Khanna Publications, 5th Edition, 1988.
2. Seetharamu&Govindaraju, "Applied Elasticity", Interline Publishing, New-Delhi, 2nd Edition, 2005.
3. C.T. WANG, "Applied Elasticity", McGraw Hill Book Co, 2nd Edition, 1953.

M20TI0103	Computer Aided Engineering	HC	L	T	P	C	Hrs /week
Duration:14 Wks			2	0	1	3	4

Prerequisites:

Prerequisite:Engg. Drawing, Computer Aided Machine Drawing, CAD/CAM/CIM

Course Objectives:

1. To make to students to understand the differences & advantages of using latest development in Digital drafting over conventional methods.
2. To make students to understand the concept and application of geometric modeling.
3. To enable the students to understand GD&T and its application.
4. To teach reverse engineering and Rapid prototyping techniques

Course Outcomes:

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

1. Understand and learn advantages of digital drafting over conventional methods.
2. Apply the knowledge of geometrical modeling to real problems.
3. Draft a model with knowledge of GD& T using a modeling tool.
4. Apply FE Principles to solve linear structural problems

BLOOM'S LEVELOF THECOURSE OUTCOMES:

CO	Bloom'sLevel					
	Remember (L1)	Understand (L2)	Apply (L3)	Analyze (L4)	Evaluate (L5)	Create (L6)
CO1		✓				

CO2			✓			
CO3			✓			
CO4			✓			

Mapping of Course Outcomes with Programme Outcomes

Course Code	POS/ COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PS O1	PS O2	PS O3
M20TI0103	**CO1**	**3**	**3**	**2**	**1**	**3**			**2**	**3**			**3**	**3**	**1**
	CO2	**3**	**2**	**2**	**1**	**3**			**3**	**2**			**3**	**3**	**1**
	CO3	**3**	**2**	**2**	**1**	**3**			**2**				**3**	**3**	**1**
	CO4	**3**	**2**	**2**	**3**	**3**			**2**	**2**			**3**	**3**	**1**

Course Contents:

Unit:1 **Introduction to CAD, CAM, CIM and CAPP**

Concept of CAD /CAM, desirable features of CAD package, drawing features in CAD – Scaling, rotation, translation, editing, dimensioning, labeling, Zoom, pan, redraw and regenerate, wire frame modeling, surface modeling and Solid modeling in relation to latest CAD packages. CAPP & their approaches CASA/SME model of CIM, CIM II, benefits of CIM. Concept of Image processing

Lab :CATIA - Module -1- Sketcher

Unit:2 **Engineering Drawing Fundamentals & GD& T**

Dimensioning standards, fundamental dimensioning rules. Types of dimensions. Types of tolerances Concepts of GD& T and its applications.

Lab :CATIA - Module -2- Part Design & Assembly

Unit:3 **Geometric modelling**

Geometric modeling - Introduction to Curves-mathematical representations, Types and Mathematical Representations of Surfaces: Surface models, surface entities, surface representation, parametric representation of analytic surfaces and synthetic surfaces, solid modeling-defeaturing, Simple problems.

Lab :CATIA - Module -3 Drafting

Unit:4 **Introduction to Finite Elements**

Introduction to the basics of CAE and FEA. Modeling considerations, types of analyses, typical procedure of FEA. Environment of CAE tools based on FEM, Building of geometrical models. Discretization, meshing, element types, Physical model, Solution and results interpretation.

Lab: Structural analyses (Linear simulation). Using ANSYS workbench

TEXT BOOKS

1. Ibrahim Zeid, R.Sivasubramanian, "CAD/CAM : THEORY & PRACTICE", McGraw Hill Publication, Second Edition, special Indian edition, 2005.
2. RafiqNoorani ,"Rapid Prototyping: principles and applications", kindle edition, 2005.
3. Robert W.Messler Jr., "Mechanisms, structures, systems & materials". McGraw Hill Publication, 2nd Edition, 2013.

REFERENCES

1. P. Radhakrishnan., S. Subramanyan., V. Raju,"CAD/CAM/CIM", New Age International(P) limited, Publisher, Third Edition ,2008.
2. D. D. Bedworth, M. R. Henderson., P. M. Wolfe , " Computer Integrated Design and Manufacturing" McGraw-Hill, 2nd Edition,1991.
3. M.P.Groover., and E. W. Zimmer,"CAD/CAM Computer Aided Design and Manufacturing", Pearson Education, 1st Edition, 2003.

M20TIS111	Design of Experiments	SC	L	T	P	C	Hrs /week
Duration:14 Wks			3	0	1	4	5

Prerequisites:

Prerequisite: Engineering Mathematics, Design of machine elements

Course Objectives:

1. To make students to understand the Concepts of random variable, probability, density function cumulative distribution function. Sample and population
2. To enable students to identify Measures of variability, Ranking method, Column effect method & Plotting method, Analysis of variance (ANOVA) in Factorial Experiments: YATE's algorithm for ANOVA,
3. To understand & identify the Types of Orthogonal Arrays, selection of standard orthogonal arrays, Linear graph sand Interaction assignment, Dummy level Technique
4. To educate the students onParameter and tolerance design concepts, Taguchi's inner and outer arrays, parameter design strategy

Course Outcomes:

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

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

BLOOM'S LEVELOF THECOURSE OUTCOMES:

CO	Bloom'sLevel					
	Remember (L1)	Understand (L2)	Apply (L3)	Analyze (L4)	Evaluate (L5)	Create (L6)
CO1	✓					
CO2						✓
CO3			✓			
CO4		✓				

Mapping of Course Outcomes with Programme Outcomes

Course Code	POS/ COs	PO1	PO2	PO3	PO4	PO5	PO6	P7	PO8	PO9	PO 10	PO 11	PSO1	PSO2	PSO3
M20TIS111	**CO1**	**3**	**1**	**2**	**-**	**3**	**-**	**-**	**3**	**-**	**-**	**-**	**1**	**2**	**1**
	CO2	**2**	**2**	**2**	**-**	**3**	**-**	**-**	**3**	**-**	**-**	**-**	**1**	**2**	**1**
	CO3	**3**	**3**	**3**	**-**	**3**	**-**	**-**	**3**	**-**	**-**	**-**	**3**	**3**	**1**
	CO4	**3**	**3**	**3**	**-**	**3**	**-**	**-**	**3**	**-**	**-**	**-**	**2**	**2**	**1**

Course Contents:

Unit1: Introduction

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

Basic Statistical Concepts: Concepts of random variable, probability, density function cumulative distribution function. Sample and population, Measure of Central tendency; Meanmedian and mode, Measures of Variability, Concept of confidence level.

StatisticalDistributions: Normal, Log Normal & Weibull distributions. Hypothesis testing, Probability plots, choice of sample size. Illustration through Numerical examples.

Unit2: Experimental Design, Analysis And InterpretationMethods

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

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

Unit 3: Quality of Experimental Design

Quality By Experimental Design: Quality, Western and Taguchi's quality philosophy, elementsof cost, Noise factors causes of variation. Quadratic loss function & variations of quadratic lossfunction**. 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 ofstandard orthogonal arrays, Linear graphs and Interaction assignment, Dummy level Technique,Compound factor method, Modification of linear graphs. Illustration through Numerical.

Unit 4: Signal To Noise Ratio, Parameter And Tolerance Design

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

Parameter And Tolerance Design: Parameter and tolerance design concepts, Taguchi's innerand outer arrays, parameter design strategy, tolerance design strategy. Illustration throughNumerical examples.

TEXT BOOKS:

1. Douglas C. Montgomery, "Design and Analysis of Experiments",Wiley India Pvt. Ltd, 5th Edition, 2007
2. Madhav S. Phadke, "Quality Engineering using Robust Design**"**, Prentice Hall PTR, Englewood Cliffs, New Jersy, 4th Edition, 1989.

REFERENCES:

1.Thomas B. Barker, MarcelDekker,"Quality by Experimental Design",Inc ASQC Quality Press.1985.

2. C.F. Jeff Wu Michael Hamada, "Experiments planning, analysis, and parameter Design optimization" ,John Wiley Editions,2002.

3. W.L. Condra, MarcelDekker, "Reliability Improvement by Experiments", Inc ASQC Quality Press.1985.

4. Phillip J. Ross, "Taguchi Techniques for Quality Engineering ", McGraw Hill International Editions, 2nd Edition, 1996.

M20TIS112	Synthesis and Analysis of Mechanisms	SC	L	T	P	C	Hrs /week
Duration:14 Wks			3	0	1	4	5

Prerequisites:

Prerequisite: Theory of Machines I and II

Course Objectives:

1. It aims at finding out degrees of freedom for any given mechanism
2. It provides the designer concept to generate the motion and path of the mechanisms in a prescribed positions
3. Synthesizing the mechanisms both analytically and graphically
4. Apply the Freudenstein's equation to synthesize the mechanism and to gives an idea about the manipulator and its dynamics

Course Outcomes:

After successful completion of the course, the students will 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 and dimensional analysis
4. Understand and classify dynamics behavior of manipulators

BLOOM'S LEVELOF THECOURSE OUTCOMES:

CO	Bloom'sLevel					
	Remember (L1)	Understand (L2)	Apply (L3)	Analyze (L4)	Evaluate (L5)	Create (L6)
CO1		✓				
CO2						✓
CO3					✓	
CO4		✓				

Mapping of Course Outcomes with Programme Outcomes

Course Code	POS/ COs	PO1	PO2	PO3	PO4	PO5	PO6	P7	PO8	PO9	PO 10	PO 11	PS O1	PS O2	PS O3
M20TIS112	CO1	3	1	2	-	3	-	-	3	-	-	-	1	2	1
	CO2	2	2	2	-	3	-	-	3	-	-	-	1	2	1
	CO3	3	3	3	-	3	-	-	3	-	-	-	3	3	1
	CO4	3	3	3	-	3	-	-	3	-	-	-	2	2	1

Course Contents:

Unit1: Introduction and Mechanics of different Mechanisms

Introduction -Links -Pairs -Chain -Mechanism –Machine structure -Degrees of freedom -Four bar chains - Terminology and definition - Planer, Spherical and Spatial Mechanisms - Grashoff's law -Grubler's criterion for plane mechanism. Inversion of mechanisms -Four bar, single slider crank chain and double slider crank chain mechanisms -Simple problems - Velocity and Acceleration of single slider crank mechanisms by Instantaneous centre and Relative velocity Method.

Lab Component: Analyzing the mechanism using Adams/ CATIA DMU Kinematics

Unit2: Velocity, Acceleration and Introduction to motion generation

Position, Velocity and Acceleration analysis; Synthesis of Mechanisms: Type, number and dimensional synthesis, introduction to coupler curve, tasks of Kinematics Synthesis; Graphical synthesis: Motion generation - two and three prescribed positions, Path generation – three prescribed positions, Function Generator - three precision points.

Lab Component: Analyzing the mechanism using Adams/ CATIA DMU Kinematics

Unit 3: Graphical and Analytical Method of motion generation

Freudenstein's equations for three point function generation. Graphical Methods: Precision positions, Structural error, Chebychev spacing, Over lay Method, Coupler curve Synthesis. Analytical Methods: Bloch's Synthesis, Freudestien's equation for three-point function generation - Cognate linkages - The Roberts-Chebychev theorem.

Lab component: Analyzing the mechanism using Adams/ CATIA DMU Kinematics

Unit 4: Manipulators and its dynamics

Manipulators : Classification, actuation and transmission systems, coordinate systems, coordinate Transformations - DH notations, inverse and forward kinematics, Manipulator dynamics from Lagrangian and Newtonian point of view.

Lab component: Simulation of various manipulators using MATLAB

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. Joseph E Shigley,"Theory of Machines &Mechanism Design", Oxford Publications, Third Edition, 2005.

REFERENCES

1. R S Khurmi& J K Gupta, "Theory of Machines", S. Chand publications, 5th edition, 2005.
2. Klafter R.D., Cmielewski T.A. and Negin, "Robot Engineering An Integrated Approach", New Delhi, M Prentice Hall, 1994.
3. Deb S.R, Robotics Technology and Flexible Automation, Second Edition, Tata McGraw Hill Publishing Co., Ltd., 1994.

M20TI0104	Design Thinking	HC	L	T	P	C	Hrs /week
Duration:14 Wks			2	0	1	3	4

Prerequisites:

Prerequisite: None

Course Objectives:

1. To enable the students to understand the basic principles of design thinking
2. To expose students to the design thinking as a tool for innovation
3. To make students to learn how to design together
4. To enable students to understand creative collaboration thinking

Course Outcomes:

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

1. Explain the principles of design thinking
2. Create empathy maps to visualize user attitudes and Develop innovative products or services for a customer base using ideation techniques.
3. Create physical prototypes / a visual representation of an idea
4. Improve prototype by testing it with a specific set of users for making it sustainable by following ethics.

BLOOM'S LEVELOF THECOURSE OUTCOMES:

CO	Bloom'sLevel					
	Remember (L1)	Understand (L2)	Apply (L3)	Analyze (L4)	Evaluate (L5)	Create (L6)
CO1		✓				
CO2						✓
CO3						✓
CO4				✓		

Mapping of Course Outcomes with Programme Outcomes

Course Code	POS/ COs	PO1	PO2	PO3	PO4	PO5	PO6	P7	PO8	PO9	PO 10	PO 11	PSO1	PSO2	PSO3
M20TI0104	CO1	3	3	1	1	1	-	-	3	-	-	-	3	3	1
	CO2	2	3	1	1	1	-	-	3	-	-	-	3	3	1
	CO3	3	3	1	1	-	-	-	3	-	-	-	3	3	1
	CO4	3	3	1	1	1	-	-	3	-	-	-	3	3	1

Course Contents:

UNIT-I: Introduction

History of design thinking, meaning, core elements, Deconstructing stereotypes through creative collaboration, watching and thinking about what designers do, the natural intelligence of design.

Problem Exploration, Case Studies from Embrace-Stanford Innovation Challenge, IDEO, GE Healthcare, The Good Kitchen- Denmark Program etc, identifying the target users for the problem selected, Survey on existing solutions for the problem identified.

UNIT-II: Empathizing and PoV

Empathizing: Powerful Visualizing tool – a method to connect to the user, Creating Empathy maps – Case studies.

Defining the problems: POV statements from User perspective. Idea generation: Methods to spark the innovative ideas – Brainstorming, Mind map, Story board, Provocation etc.

UNIT-III: Prototyping

What is a prototype? - Prototyping as a mind-set, prototype examples, prototyping for products; Why we prototype? Fidelity for prototypes, Process of prototyping- Minimum Viable prototype

Prototyping for digital products: What's unique for digital, Preparation; Prototyping for physical products: What's unique for physical products, Preparation?

UNIT-IV: Testing and Collaboration

Testing prototypes with users, Collaboration, Design Process, and Creative Design. Design Expertise, Design Intelligence, Development of Expertise, Novice to Expert

PRACTICE SESSION:

Sl.No	**Name of the Practice Session**	**Tools and Techniques**	**ExpectedSkill /Ability**
1	Identifying the problem that can be solved using Design Thinking approach	Observation and survey	Develop identifying human centered problems
2	Build the empathy maps for simple problems like single user	Visualization	Develop ability to understand other's emotions
3	Build the detailed empathy maps for problem identified in the teams formed	Visualization	Develop ability to understand other's emotions
4	Presentation by student teams	PPT	Develop ability to express their views

5	Obtain the insights into user's problems and make PoV statement	Understanding	Develop making problem statements from user perception
6	Presentation by student teams	PPT	Develop ability to express their views
7	Carry out Brain storming between the groups and generate as many as ideas possible	Ideation tools	Develop innovative mind set
8	Prototype for best 3 ideas selected	Sketching, simple model making etc	Develop prototyping techniques
9	Presentation by student teams	PPT	Develop ability to express their plan
10	Test the developed prototype with set of identified users	Google forms , cold calls, social media etc.	Develop understanding of various testing methods
11	Pitching final solution	PPT	Develop ability to express their views

TEXT BOOKS:

1. Gavin Ambrose, Paul Harris,**"**Basics Design-Design Thinking", AVA Publishing, 1st Edition,2010
2. Kathryn McElroy, "Prototyping for Designers: Developing the best Digital and Physical Products", O'Reilly, 1st Edition,2017.

REFERENCE BOOKS:

1. Idris Mootee, "Design Thinking for Strategic Innovation", John Wiley & Sons,1st Edition, 2013.
2. Michael G. Luchs, Scott Swan, Abbie Griffin, "Design Thinking – New Product Essentials from PDMA", Wiley, 1st Edition,2015.
3. Vijay Kumar, "101 Design Methods: A Structured Approach for Driving Innovation in Your Organization", 1st Edition,2012.

SEMESTER –II

M20TI0201	Advanced Engineering Materials	HC	L	T	P	C	Hrs /week
Duration:14 Wks			2	0	1	3	4

Prerequisites:

Prerequisite:Mechanics of Materials/Engg Mathematics

Course Objectives:

1. To introduce metals and alloys
2. To study the characteristics and applications of ferrous and non-ferrous metals
3. To introduce composites, shape memory alloys and its application
4. To learn types of composites, piezoelectric materials, magnetostrictive materials, and Self-Healing Polymers.
5. To study the Ni-based, Fe-based, Co-based super alloys, and properties and its applications, Cu-based and NiTi shape memory alloys properties and its applications

Course Outcomes:

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

1. Describe ferrous, non-ferrous, ceramics, stress strain behavior, true stress and true strain and strengthening mechanisms.
2. Predict the properties of composites, types of composites and super alloys.
3. Explain smart materials & shape memory alloys
4. Demonstrate the synthesis & processing techniques of nanomaterial.

BLOOM'S LEVELOF THECOURSE OUTCOMES:

CO	Bloom'sLevel					
	Remember (L1)	Understand (L2)	Apply (L3)	Analyze (L4)	Evaluate (L5)	Create (L6)
CO1		✓				
CO2				✓		
CO3		✓				
CO4			✓			

Mapping of Course Outcomes with Programme Outcomes

Course Code	POS/ COs	PO1	PO2	PO3	PO4	PO5	PO6	P7	PO8	PO9	PO 10	PO 11	PSO1	PSO2	PSO3
M20TI0201	CO1	3	3	1	1	1	-	-	2	-	-	-	3	3	1
	CO2	2	3	1	1	1	-	-	2	-	-	-	3	3	1
	CO3	3	3	1	1	-	-	-	2	-	-	-	3	3	1
	CO4	3	3	1	1	1	-	-	2	-	-	-	3	3	1

Course Contents:

Unit1: Metals and Alloys

Metals and Alloys: Classification of Metals, Ceramics, Polymers and composites. Single crystal, polycrystalline materials, elastic deformation, anelasticity, plastic deformation, deformation mechanisms; slip and twinning, slip systems-BCC, FCC and HCP, slip in single crystals. True stress–true strain and simple numerical.

Strengthening Mechanisms: Strengthening by grain size reduction, Hall-Petch and inverse Hall-Petch equation, Solid solution strengthening, precipitation hardening, dispersion strengthening, strain hardening, Yield point phenomenon, recovery, recrystallization and grain growth.

Unit2: Composite Materials and Super alloys

Composite Materials: Introduction, Particle reinforced composites: large particle composites, dispersion strengthened composite, Fiber reinforced composites: Influence of fiber length, Influence of fiber orientation and concentration, fiber phase, matrix phase, matrix and reinforcement materials.

Types of composite materials: Metal Matrix Composites, Polymer matrix composites and Ceramic matrix Composites and carbon – carbon composites and hybrid composites. Structural composites: Laminar composites and sandwich panels.

Super alloys: Introduction, Ni-based, Fe-based, Co-based super alloys, Ni-Al phase diagram, Fe-Ni phase diagram, different phases, properties of super alloys and its applications

Unit 3: Advanced ceramics, Polymer materials and Smart materials

Advanced ceramics: glass ceramics, traditional ceramics and modern ceramics, structure of ceramics; noncrystalline ceramics and crystalline ceramics; Nacl structure, fluorite structure, perovskite structure, ceramic materials; piezo and ferroelectric ceramics, ferromagnetic ceramics, ceramic fibers, high alumina ceramics, silicon carbide. Metallic glasses.

Polymer materials: polymerization mechanism; Addition polymerization, condensation polymerization and electrochemical polymerization, synthetic polymers; thermosets, thermoplastics: cross linked polymer, polymer alloy, homo-polymer and copolymer. Defects in polymers. Stress strain behavior of polymer. Viscoelastic deformation. Viscoelastic creep. Deformation mechanisms:

Smart materials: Introduction, classification of Smart Materials, Properties of Smart Materials, Piezoelectric Materials, Electrostrictive Materials, Magnetostrictive Material and Self-Healing Polymer.

Unit 4: Nanomaterials synthesis and Characterization

Nanomaterials synthesis: Introduction, synthesis of nano materials: top down approach: Ball milling, nano lithography : types of lithography, lithography using UV light & laser beam, X-rays,

Electron beam lithography. Bottom up approach: Synthesis of nano materials, vapour phase deposition-chemical vapor deposition(CVD) and physical vapor deposition(PVD). Chemical method; Sol-gel Method.

Characterization Techniques: Structural and Mechanical Characterization; X-ray diffraction (XRD): fundamentals of X-ray scattering, Brag's law, factor affecting the intensity, indexing, peak broadening, applications of XRD. Scanning electron microscopy (SEM); working principle, detectors, modes of SEM. Transmission electron microscopy(TEM); working principle, sample preparation, selected area electron diffraction, bright field and dark field mode. Nanoindentation, Atomic force microscopy.

TEXT BOOKS

1. William D. Callister Jr ," Materials Science & Engineering -an introduction",. John Wiley & Sons, 4th edition, 1985.
2. R. A. Flinn& P. K. Trojan, "Engg. Materials & their applications",Jaico Publishing House, 4th edition, 1990.
3. M. V. Gandhi and B. So Thompson,"Smart Materials and Structures", Chapman & Hall, London; New York – 1992.

REFERENCES

1. James.F.Shackleford, "Introduction to Material Science and Engineering" Mc Millan, NY ,7th edition, 2000.
2. Chawla K.K, " Composite Materials - Science and Engineering", Springer - Verlag, Newyork-2nd edition, 1998.
3. Mick Wilson, KamaliKannangara,"Nanotechnology – Basic Science and Emerging Technologies" ,Overseas Press India Private Limited, First Indian Edition, 2005.

M20TI0202	Advanced Finite Element Methods	HC	L	T	P	C	Hrs /week

Duration:14 Wks			3	0	1	4	5

Prerequisites:

Prerequisite:Mechanics of Materials,Engg Mathematics and CAE

Course Objectives:

1. To enable the students to understand the mathematical and physical principles underlying the Finite Element Method (FEM) as applied to solid mechanics and heat transfer problems.
2. To provide systematic and comprehensive knowledge of basics of Finite element method as an analysis tool.
3. To teach the students the characteristics of various elements and selection of suitable elements for the problems being solved.
4. To make the students derive finite element equations for simple and complex elements.
5. To make the student solve for field variable for thermal composite wall problems

Course Outcomes:

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

1. Explain the different types of analysis methods, types of FE elements, various approaches in Finite Element Method,
2. Analyze the Interpolation polynomialsby Euler-Lagrange equations and Solution to 2-D elements
3. Determine the stiffness matrix and unknown DOFs of plates and shells and derive shape functions for Higher Order Elements
4. Formulate FE Procedures for composite laminates and dynamic problems

BLOOM'S LEVELOF THECOURSE OUTCOMES:

CO	Bloom'sLevel					
	Remember (L1)	Understand (L2)	Apply (L3)	Analyze (L4)	Evaluate (L5)	Create (L6)
CO1		✓				
CO2				✓		
CO3					✓	
CO4					✓	

Mapping of Course Outcomes with Programme Outcomes

Course Code	POS/ COs	PO1	PO2	PO3	PO4	PO5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PS O1	PS O2	PS O3
M20TI0202	**CO1**	**3**	**2**	**2**					**3**				**2**	**3**	
	CO2	**3**	**2**	**3**					**3**				**3**	**3**	1
	CO3	**3**	**3**	**2**					**3**				**3**	**3**	1
	CO4	**3**	**3**	**3**					**3**				**3**	**3**	1

Course Contents:

Unit:1 **Fundamentals of FEM**

Background of Various Stress analysis methods, comparison of FEM with classical methods. Advantages and limitations of FEM, Steps involved in FEM, Applications of FEM and FEM Packages.

Discretization: Element shapes and behavior – Choice of element types – size and number of elements – Element shape and distortion – Location of nodes – Mesh Quality Parameters ,Principle of minimum PE.

Lab Component: Meshing of given machine member using a FE Software

Unit:2 **Interpolation Models and FE Analysis of 2D Problems**

Interpolation polynomials- Linear, quadratic and cubic. Simplex complex and multiplex elements, Convergence Criteria -2D PASCAL's triangle.

2-D Problems: CST and quadrilateral elements-Shape functions in NCS, Strain displacement matrix and Jacobian for triangular element. (no derivation), Iso parametric, Sub parametric and Super parametric elements. Numerical integration.

Lab Component: Solving various 2 D problems using a FE Software

Unit:3 **Plates and Shells**

Basics of plates and shell theories: Classical thin plate Theory, Shear deformation Theory and Thick Plate theory. Finite Element Formulations for triangular and quadrilateral Plate elements. Finite element formulation of flat, curved Shell elements

Lab Component: Solving the given plate using a FE Software

Unit:4 **Dynamic Problems and Composite Laminates**

Finite Element Formulation for point/lumped mass and distributed masses system: Finite Element Formulation of one dimensional dynamic analysis: bar and beam element.

Finite Element Formulation of Two dimensional dynamic analysis: triangular membrane and axisymmetric element. Evaluation of Eigen values and Eigen vectors applicable to bars, beams.

Finite Element Analysis of Composite Laminates: Introduction, Classical Laminated Plate Theory, First Order Shear Deformation Theory, Computational Aspects, Continuum Formulation.

Lab Component: Finding out of Eigen Vector and Eigen Values of given member using a FE Software

TEXT BOOKS

1. Bhavikatti S.S, **"***Finite Element Analysis"*, 4th edition, New Delhi, New Age International publishers, 4th Edition,2006.
2. ChandrapatlaT.R. andA.D Belegunde A.D, **"***Finite Elements in Engineering",* New Delhi, PHI, 3rd edition 2008.

REFERENCES

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

M20TI0203	Design for Manufacturing, Assembly	HC	L	T	P	C	Hrs

	and Environment						/week
Duration:14 Wks			4	0	0	4	4

Prerequisites:

Prerequisite:Design**:** SOM, Manufacturing Technology

Course Objectives:

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 Outcomes:

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

1. Explain 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.

BLOOM'S LEVELOF THECOURSE OUTCOMES:

CO	Bloom'sLevel					
	Remember (L1)	Understand (L2)	Apply (L3)	Analyze (L4)	Evaluate (L5)	Create (L6)
CO1		✓				
CO2					✓	
CO3					✓	
CO4						✓

Mapping of Course Outcomes with Programme Outcomes

Course Code	POS/ COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PS O1	PSO 2	PSO 3
M20TI 0203	CO1	3	3	1	1	1	-	-	3	-	-	-	3	3	
	CO2	2	3	1	1	1	-	-	3	-	-	-	3	3	1
	CO3	3	3	1	1	-	-	-	3	-	-	-	3	3	1
	CO4	3	3	1	1	1	-	-	3	-	-	-	3	3	1

Course Contents:

Unit:1 Introduction to DFMA and Selection of Materials

Introduction: Meaning of Design for Manufacture and Assembly, how DFMA works, Advantages of Applying DFMA During Product Design, Typical DFMA Case Studies, Overall Impact of DFMA on Industry. General Requirements for Early Materials and Process Selection , Selection of Manufacturing Processes, Process Capabilities, Selection of Materials, Primary Process/Material Selection

Unit:2 Product Design for Manual Assembly

Design for Manual Assembly: General Design Guidelines for Manual Assembly, Development of the Systematic DFA Methodology, Assembly Efficiency, Effect of Part Symmetry, Thickness, Weight on Handling Time, Effects of Combinations of Factors, Effect of Chamfer Design on Insertion Operations , Avoiding Jams During Assembly, Application of the DFA Methodology , Types of Manual Assembly Methods , Assembly Quality

Unit:3 Design for High speed Automatic Assembly, Robot Assembly and Case Studies

High speed Automatic Assembly & Robot Assembly: Design of Parts for High-Speed Feeding and Orienting – Example, Additional Feeding Difficulties, High-Speed Automatic Insertion, Analysis of an Assembly, General Rules for Product Design for Automation, Design of Parts for Feeding and Orienting, Product Design for Robot Assembly.

Design for Manufacture and Case Studies: Identification of uneconomical design, Design for economy

Unit:4 Linking DFM with CAD and Introduction to TRIZ

Introduction, General Considerations for Linking CAD and DFMA, Geometric Representation Schemes in CAD Systems , Design Process in a Linked CAD/DFMA Environment, Expert Design and Cost Estimating Procedures

Introduction to TRIZ and Case Studies: Introduction to TRIZ, evolution of TRIZ, Principles of TRIZ, Case Studies.

TEXT BOOKS:

1. Geoffrey Boothroyd,“Hand Book of Product Design”, Marcel Dekker Inc., NY, 1992.
2. Harry Peck , “Design for Manufacture”, Pittman Publication, 1983.
3. Robert Matousek, “Engineering Design - A systematic approach” ,Blackie & sons Ltd.
4. Hand Book of Product Design for Manufacturing, James G. Bralla, McGraw Hill Co.

REFERENCES:

1. Swift K.G , “Knowledge based design for manufacture”, Kegan Page Ltd., 1987.
2. Geoffrey Boothroyd, Assembly Automation and Product Design, Marcel Dekker Inc., NY, 3rd Edition,2010.

M20TI0204	Project Management	HC	L	T	P	C	Hrs /week
Duration:14 Wks			2	0	1	3	4

Prerequisites:

Prerequisite: **:**Fundamentals of production process

Course Objectives:

1. To enable the students to understand the fundamental concepts of Project management, systems approach to project management and role of project manager
2. To provide systematic knowledge for generating ideas, project planning process and project budgeting
3. To teach the students to integrate project elements and manage quality and risk management of project
4. To make the students to prepare Gantt chart using MS office project software to schedule the project and monitor the progress of project
5. To make the student to evaluate performance of project and make project audits

Course Outcomes:

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

1. Describe elements of project management, project planning process , its execution and monitoring the progress of the project
2. Generate project ideas and prepare project budget and project life cycle costs
3. Integrate the project processes and manage quality and risk of the project
4. Construct network diagrams to determine project completion time and floats

BLOOM'S LEVELOF THECOURSE OUTCOMES:

CO	Bloom'sLevel					
	Remember (L1)	Understand (L2)	Apply (L3)	Analyze (L4)	Evaluate (L5)	Create (L6)
CO1		✓				
CO2						✓
CO3				✓		
CO4						✓

Mapping of Course Outcomes with Programme Outcomes

Course Code	POS / COs	PO1	PO2	PO3	PO4	PO5	PO6	P7	PO8	PO9	PO 10	PO 11	PSO1	PSO2	PSO3
M20TI 0204	CO1	2	2	2		2			3	2			2	3	1
	CO2	3	3	1		2			3	2			3	3	1
	CO3	3	3	2		2			3	2			3	3	1
	CO4	3	3	1		2			3	2			3	3	1

Course Contents:

UNIT-I: Introduction to project management

Introduction: Meaning of Project, Project goal, Evolution of Project management, and Different forms of Project Management, project management in industrial settings and in service sector, organizations and environment of project management, role of the project manager, selection of project teams, and systems approach to Project management.

UNIT-II:Project Ideas and planning process and Budgeting

Generation of ideas, monitoring the environment, corporate appraisal, scouting for project ideas, preliminary screening, project rating index, sources of positive net present value. Project costing,

The Planning Process – Project scope management, collect requirements define scope, Work Break down Structure (WBS), Project execution plan (PEP) Role of Multidisciplinary teams.
Budget the Project – Methods. Cost Estimating and Improvement. Budget uncertainty and risk management
Organizational influences on project management, project stake holders & governance, project team, project life cycle.

UNIT-III: Project integration, quality and risk management

Project Integration Management: Develop project charter, develop project management plan, direct & manage project work, monitor & control project work, perform integrated change control, close project or phase.
Project Quality management: Plan quality management, perform quality assurance, and control quality
Project Risk Management: Plan risk management, identify risks, perform qualitative risk analysis, perform quantitative risk analysis, plan risk resources, control risk.

UNIT-IV: Project Scheduling, monitoring

Project Scheduling: Project implementation scheduling, Effective time management, Different scheduling techniques, Resources allocation method, PLM concepts. Project life cycle costing.
Tools & Techniques of Project Management: Bar (GANTT) chart, bar chart for combined activities, logic diagrams and networks Critical Path method (CPM), Project evaluation and review Techniques (PERT) Planning
Computerized project management-**MS Office Project tool to construct and monitor Projects, case studies**
Project Performance indicator, The DM and CM companies for better project management, Project evaluation, and project auditing and project termination

TEXT BOOKS:

1. John M. Nicholas, “Project Management for Business and Technology - Principles and Practice” ,Pearson Education,Second Edition, 2006.
2. Clifford F. Grey, Erik W. Larson, Gautam V. Desai “Project Management The Managerial Process” Tata Mcgraw Hill, Fourth Edition, 2010

REFERENCE BOOKS:

1. Rory Burke, "Project Management – Planning and Controlling Techniques", John Wiley & Sons, 4th Edition, 2004,
2. Prasanna Chandra, "Project Planning Analysis Selection Financing Implementation & Review", Tata McGraw Hill Publication, 7th Edition, 2010,Project Management; S. Choudhary; Tata McGraw Hill.
3. Harvey Maylor, Project Management, Third Edition, Pearson Education, 2006.
4. Harold Kerzner, "Project Management A System approach to Planning Scheduling & Controlling", John Wiley & Sons Inc., 11th Edition, 2013,
5. Sadhan Choudhury "Project Management "Tata McGraw-Hill Education, Published on 1988

M20TIS211	Mechatronics Product Design	SC	L	T	P	C	Hrs /week
Duration:14 Wks			2	0	1	3	4

Prerequisites:

Prerequisite:CAD/CAM, Engineering Mathematics, Basic Electronics.

Course Objectives:

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 Outcomes:

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

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

BLOOM'S LEVELOF THECOURSE OUTCOMES:

CO	Bloom'sLevel					
	Remember (L1)	Understand (L2)	Apply (L3)	Analyze (L4)	Evaluate (L5)	Create (L6)
CO1		✓				
CO2				✓		
CO3						✓
CO4			✓			

Mapping of Course Outcomes with Programme Outcomes

Course Code	POS/ Cos	PO1	PO2	PO3	PO4	PO5	PO6	P07	PO8	PO9	PO 10	PO 11	PS O1	PS O2	PSO3
M20TIS 211	CO1	2	2	3	-	2	3	-	3	3	-	-	2	3	1
	CO2	2	2	2	-	3	3	-	3	3	-	-	2	2	1
	CO3	3	3	3	-	3	3	-	3	3	-	-	3	2	2
	CO4	3	3	3	-	3	3	-	3	3	-	-	3	3	2

Course Contents:

Unit 1 Introduction to Mechatronics

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.

Unit 2 Sensors

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.

Unit 3 Principles of Electronic system communication

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.

Unit 4 First-second order system in series

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.

Text Books: 1. W.Bolton, "Mechatronics" ,Addison Worley Longman Pvt. Ltd., India Brander, Delhi, 2006.

2. Mikel P Groover, "Automation Production System System and CIMS", , Printice Hall of India Pvt. Ltd, New Delhi, 2005.

References: 1. W.Bolton, "Mechatronics", Addison Worley Longman Pvt. Ltd., India Brander, Delhi.

M20TIS212	Vehicle Dynamics	SC	L	T	P	C	Hrs /week
Duration:14 Wks			2	0	1	3	4

Prerequisites:

Prerequisite:Engg. Mathematics, Mechanical vibration, Kinematics, Mechanics of Materials.

Course Objectives:

1. To know about the application of basic mechanics principles for dynamic analysis of vehicles.
2. To study the behavior of vehicle.

Course Outcomes:

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

1. Explain vehicle performance, ride and handling characteristics of a vehicle, wheel alignment angles, kinematics and compliance and steering performance
2. Estimate the dynamic loads acting on each wheel and predict their effect on vehicle behaviour
3. Predict maximum acceleration and braking performance using Mu Circles and propose technologies to overcome vehicle instabilities during acceleration and braking
4. Analyze the factors that control Understeer and oversteer behaviour of vehicles and propose technologies to control yawing behaviour of ground vehicles

BLOOM'S LEVELOF THECOURSE OUTCOMES:

CO	Bloom'sLevel					
	Remember (L1)	Understand (L2)	Apply (L3)	Analyze (L4)	Evaluate (L5)	Create (L6)
CO1		✓				
CO2					✓	
CO3					✓	
CO4				✓		

Mapping of Course Outcomes with Programme Outcomes

Course Code	POS/COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	P0 7	PO 8	PO 9	PO 10	PO 11	PS O1	PS O2	PSO 3
M20TIS 212	**CO1**	**2**	**2**	**3**	**-**	**-**	**-**	**-**	**3**	**-**	**-**	**-**	**2**	**3**	**1**
	CO2	**2**	**2**	**2**	**-**	**-**	**-**	**-**	**3**	**-**	**-**	**-**	**2**	**2**	**1**
	CO3	**3**	**3**	**3**	**-**	**-**	**-**	**-**	**3**	**-**	**-**	**-**	**3**	**2**	**2**
	CO4	**3**	**3**	**3**	**-**	**-**	**-**	**-**	**3**	**-**	**-**	**-**	**3**	**3**	**2**

Course Contents:

Unit 1 Introduction

Introduction: Review of Rigid Body Dynamics, Vehicle dynamics, Terminology, Vehicle Co-ordinate Systems, Vehicle inertia, properties; Forward vehicle dynamics: Axle loads of vehicle and, vehicle/trailer combinations.

Unit 2 Tyre Mechanics

Tyre Mechanics: Terminology, Elastic Band Model for longitudinal, slip, Simple model for lateral slip, combined longitudinal/lateral, slip (friction ellipse), Magic Formula; Vehicle Aerodynamics: Aerodynamic forces and Moments, Total road loads.

Longitudinal Dynamics of Road Vehicles: Acceleration, Performance, Braking Performance

Lab Component: Simulating acceleration and braking performance using ADAMS/Simulink.

Unit 3 Handling Characteristics of Road Vehicles

Suspension, Handling Characteristics of Road Vehicles: steering geometry, Handling Characteristics of a two axle vehicles, Steady-State, response to steering input, Testing of handling characteristics; Transient Response Characteristics Road Vehicles, Criteria for Directional Stability

Lab Component: Simulating handling characteristics using ADAMS/Simulink.

Unit 4 Ride Characteristics of Road Vehicles

Ride Characteristics of Road Vehicles: Ride excitation sources, Human response to vehicle vibration, Vehicle ride models, Road profile roughness and modeling, Evaluation of vehicle vibration in relation to the ride comfort criterion

NVH :Imapct of NVH on Vehicle Dynamics

Lab Component: Simulating ride characteristics using ADAMS/Simulink

TEXT BOOKS

1. Gillespie, T.D., "Fundamentals of vehicle dynamics", Warrendale, PA: Society of Automotive Engineers, 1992.
2. Wong, J.Y., "Theory of ground vehicles". John Wiley &Sons., 2008.
3. Rajamani, R.,"Vehicle dynamics and control", Springer Science & Business Media, 2011.

REFERENCES

1. Dean Karnopp,"Vehicle Stability", 1st edition, Marcel Dekker, 2004.
2. NakhaieJazar. G.,"Vehicle Dynamics: Theory and Application", 1st edition, Springer, 2008.
3. Michael Blundell & Damian Harty,"The Multibody Systems Approach to Vehicle Dynamics", Elsevier Limited, 2004.
4. Hans B Pacejka,"Tire and Vehicle Dynamics", 2nd edition, SAE International,2005.

M20TIS221	Additive Manufacturing	HC	L	T	P	C	Hrs /week
Duration:14 Wks			3	0	0	3	3

Prerequisites:

Prerequisite: **CAD/CAM/CIM**

Course Objectives:

1. To explore technology used in additive manufacturing.
2. To understand importance of additive manufacturing in advance manufacturing process.
3. To acquire knowledge, techniques and skills to select relevant additive manufacturing process.
4. To explore the potential of additive manufacturing in different industrial sectors.
5. To apply 3D printing technology for additive manufacturing.

Course Outcomes:

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

1. Analyze and select suitable process and materials used in Additive Manufacturing.
2. Identify, analyze and solve problems related to Additive Manufacturing.
3. Apply knowledge of additive manufacturing for various real-time applications
4. Apply technique of CAD and reverse engineering for geometry transformation in Additive Manufacturing

BLOOM'S LEVELOF THECOURSE OUTCOMES:

CO	Bloom'sLevel					
	Remember (L1)	Understand (L2)	Apply (L3)	Analyze (L4)	Evaluate (L5)	Create (L6)
CO1				✓		
CO2				✓		
CO3			✓			
CO4			✓			

Mapping of Course Outcomes with Programme Outcomes

Course Code	POS/ COs	PO1	PO2	PO3	PO4	PO5	PO6	P7	PO8	PO9	PO 10	PO 11	PSO1	PSO2	PSO3
M20TIS221	**CO1**	**3**	**1**	**2**					**2**	**2**			**2**	**3**	**1**
	CO2	**3**	**2**	**2**					**3**	**2**			**2**	**3**	**2**
	CO3	**3**	**1**	**2**					**3**	**2**			**2**	**3**	**2**
	CO4	**3**	**1**	**2**					**3**	**2**			**2**	**3**	**2**

Course Contents:

Unit:1Introduction and AM Applications:

Introduction, Basic principle need and advantages of additive manufacturing, Procedure of product development in additive manufacturing, Classification of additive manufacturing processes, Materials used in additive manufacturing, Challenges in Additive Manufacturing.

AM Applications: Functional models, Pattern for investment and vacuum casting, Medical models, art models, Engineering analysis models, Rapid tooling, new materials development, Bi-metallic parts, Re-manufacturing. Application examples for Aerospace, defense, automobile, Bio-medical and general engineering industries

Unit:2Additive Manufacturing Processes:

Additive Manufacturing Processes: Z-Corporation 3D-printing, Stereo lithography apparatus (SLA), Fused deposition modeling (FDM), Laminated Object Manufacturing (LOM), Selective deposition lamination (SDL), Ultrasonic consolidation, Selective laser sintering (SLS), Laser engineered net shaping (LENS), Electron beam free form fabrication (EBFFF), Electron beam melting (EBM), Plasma transferred arc additive manufacturing (PTAAM), Tungsten inert gas additive manufacturing (TIGAM), Metal inert gas additive manufacturing (MIGAM).

Unit:3 Design for AM and **Guidelines for process selection:**

Design for AM: Motivation, DFMA concepts and objectives, AM unique capabilities, Exploring design freedoms, Design tools for AM, Part Orientation, Removal of Supports, Hollowing out

parts, Inclusion of Undercuts and Other Manufacturing Constraining Features, Interlocking Features, Reduction of Part Count in an Assembly, Identification of markings/ numbers etc.

Guidelines for process selection: Introduction, selection methods for a part, challenges of selection, example system for preliminary selection, production planning and control

Unit:4 Pre and Post Processing in Additive Manufacturing

Pre-Processing in Additive Manufacturing, Preparation of 3D-CAD model, Reverse engineering, Reconstruction of 3D-CAD model using reverse engineering, Part orientation and support generation, STL Conversion, STL error diagnostics, Slicing and Generation of codes for tool path, Surface preparation of materials.

Post-Processing in Additive Manufacturing, Support material removal, surface texture improvement, accuracy improvement, aesthetic improvement, preparation for use as a pattern, property enhancements using non-thermal and thermal techniques, Brief information on characterization techniques used in additive manufacturing, Applications of additive manufacturing in rapid prototyping, rapid manufacturing, rapid tooling, repairing and coating. Future scope in Additive Manufacturing Modelling and Simulation: Thermal model to predict size of deposition such as width and height of deposition, Finite element simulation of additive process.

Lab : Demo on 3 D Printing

TEXT BOOKS

1. Gibson, I, Rosen, D W., and Stucker,B., "Additive Manufacturing Methodologies: Rapid Prototyping to Direct Digital Manufacturing",Springer, 2010
2. Chua C.K., Leong K.F., and Lim C.S., "Rapid prototyping: Principles and applications", World Scientific Publishers, Third Edition,2010.
3. Chee Kai Chua, Kah Fai Leong, "3D Printing and Additive Manufacturing: Principles and Applications": Rapid Prototyping, World Scientific Publishers, Fourth Edition, 2014.
4. Gebhardt A., "Rapid prototyping", Hanser Gardener Publications, 2003

REFERENCES

1. Liou L.W. and Liou F.W., "Rapid Prototyping and Engineering applications: A tool box for prototype development", CRC Press, 2007.
2. Kamrani A.K. and Nasr E.A., "Rapid Prototyping: Theory and practice", Springer, 2006.
3. Mahamood R.M., Laser Metal Deposition Process of Metals, Alloys, and Composite Materials, Engineering Materials and Processes, Springer International Publishing AG, 2018
4. Ehsan Toyserkani, Amir Khajepour, Stephen F. Corbin, "Laser Cladding", CRC Press, 2004.

M20TIS222	Computational Fluid Dynamics	SC	L	T	P	C	Hrs /week
Duration:14 Wks			3	0	0	3	3

Prerequisites:

Fluid Mechanics, Heat Transfer, Differential and Integral mathematics

Course Objectives:

1. To introduce concepts of Computational fluid dynamics
2. To understand fluid flow equations like, Continuity -Momentum and energy equations
3. To differentiate finite difference, finite volume and finite element methods
4. To understand different numerical schemes used for solving equations and stability and convergence
5. To learn modeling of fluid domain and its discretization using CFD tool

Course Outcomes:

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

1. Explain fluid flow equations like continuity, momentum and energy
2. Differentiate finite difference, finite element and finite volume methods, model fluid flow domain and discretize with appropriate commercial tool
3. Explain different numerical scheme that are used in fluid flow problem and their characteristics like convergence stability and errors
4. Simulate internal and external flow problems for compressible fluid

BLOOM'S LEVELOF THECOURSE OUTCOMES:

CO	Bloom'sLevel					
	Remember (L1)	Understand (L2)	Apply (L3)	Analyze (L4)	Evaluate (L5)	Create (L6)
CO1		✓				
CO2		✓				
CO3		✓				
CO4					✓	

Mapping of Course Outcomes with Programme Outcomes

Course Code	POS/ COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PSO1	PSO2	PSO 3
M20TIS 222	CO1	1	2	2					3	2			1	2	1
	CO2	2	2	3					3	2			2	2	1
	CO3	2	2	2					3	2			2	2	1
	CO4	2	2	2					3	2			1	2	1

Course Contents:

UNIT-I: Introduction and Governing Equations

Introduction - Impact and applications of CFD in diverse fields - Governing equations of fluid dynamics – Continuity - Momentum and energy - Generic differential form for governing equations - Initial and Boundary conditions - Governing equations for boundry layers -Classification of partial differential equations – Hyperbolic - Parabolic - Elliptic and Mixed types - Applications and relevance.

UNIT-II: Discretization

Basic aspects of discretization - Discretization techniques – Finite difference - Finite volume and Finite Element Method– Comparison of discretization by the three methods - Introduction to Finite differences three-dimensional conduction in Cartesian coordinates – Explicit - Implicit - Crank-Nicolson - ADI scheme – Stability criterion. Difference equations - Numerical errors -.truncation errors, round off error.

UNIT-III: CFD Tool

Geometry-meshing-grid independent test, mesh refinement analysis, validation, results. Turbulent modeling, convergence, accuracy. Examples.

UNIT-IV: Advance CFD

Introduction, large eddy simulation, direct numerical simulation, multi flow combustion, case study, future in CFD.

TEXT BOOKS:

1. J.D. Anderson, Jr., “Computational Fluid Dynamics – The basics with applications”, McGraw-Hill, Incs, 2nd Edition,1995.

REFERENCE BOOKS:

1. K. Muralidhar, T. Sundarajan, “Computational Fluid Flow and Heat Transfer”, Narosa Publishing House, New Delhi, 2001.

2. S.V. Patankar, “Numerical Heat Transfer and Fluid Flow”, 1999.

3. JiyuanTu,“Computational Fluid Dynamics – A practical approach-Elsevier publication,3rd Edition, 2018.

M20TIS223	Robotics and Its Applications	SC	L	T	P	C	Hrs /week
Duration:14 Wks			3	0	0	3	3

Prerequisites:

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 Outcomes:

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

1. Formulate the mathematical representation of Robots and Kinematics of Robot
2. Determine the Trajectory planning
3. Explain 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.

BLOOM'S LEVELOF THECOURSE OUTCOMES:

CO	Bloom'sLevel					
	Remember (L1)	Understand (L2)	Apply (L3)	Analyze (L4)	Evaluate (L5)	Create (L6)
CO1					✓	
CO2					✓	
CO3		✓				
CO4			✓			

Mapping of Course Outcomes with Programme Outcomes

Course Code	POS/ COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PS O1	PSO2	PS O3
M20TIS 223	CO1	3	1	2					2	2			2	3	1
	CO2	3	2	2					3	2			2	3	1
	CO3	3	1	2					3	2			2	3	1
	CO4	3	1	2					3	2			2	3	1

Course Contents:

Unit:1 Introduction:

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.

Unit:2Mathematical representation of Robots, Kinematics of Robot

Mathematical representation of Robots, kinematics of Robot-Introduction, Matrix representation, Homogeneous transformation, forward and inverse Kinematics, Inverse kinematics programming, dexterity, transformation matrix for 3R manipulator, puma 560 & SCARA manipulator. Introduction to dynamics of manipulator

Unit:3 Trajectory planning

Trajectory planning: Avoidance of obstacles using uniformed path search breadth first, depth first search, informed path search, A*, best first greedy search & B* algorithms. Neural network to solve inverse kinematics problems.

Unit:4 Machine Vision systems

Machine vision systems: Introduction-Image processing vs image analysis, image acquisition, digital images-sampling and quantization- Image definition, levels of computation

TEXT BOOKS

1. Saeed B. Niku, “Introduction to Robotics Analysis, Systems, Applications”, Pearson Education India, PHI, 2nd edition, 2003.

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. Robotics and Image Processing, P.A. Janaki Raman, Tata McGraw-Hill, 1991.

Semester III:

M20TI0301	Industrial Internship	HC	L	T	P	C	Hrs /week
Duration:4 Wks			0	0	4	4	8

Prerequisites:

All previous courses taught in earlier semesters

Course Objectives:

1.To give exposure to industrial activities.
2.To learn various aspects of activities carried out in industry.
3.To understand application of concepts of mechanical engineering in industry.
4.To know various process and machines used to make a product.
5.To gain overall idea about industry.

Course Outcomes:

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

1. Explain various aspects of industry working principle and work culture.
2. Explain the respective company methods and process used to make a product.
3. Explain the management philosophy and concept used in particular industry.
4. Explain the activities of the particular industry and concept of entrepreneurship

BLOOM'S LEVELOF THECOURSE OUTCOMES:

CO	Bloom'sLevel					
	Remember (L1)	Understand (L2)	Apply (L3)	Analyze (L4)	Evaluate (L5)	Create (L6)
CO1		✓				
CO2		✓				
CO3		✓				
CO4		✓				

Mapping of Course Outcomes with Programme Outcomes

Course Code	POS/ Cos	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	P0 7	PO 8	PO 9	PO 10	PO 11	PS O1	PSO 2	PS O3
M20TI0 301	CO1	2	1	1	-	-	2	3	-	-	-	-	1	2	2
	CO2	2	2	1	-	-	2	3	-	-	-	-	1	1	2
	CO3	2	2	3	-	-	-	3	-	-	-	-	1	1	2
	CO4	2	2	3	-	-	2	3	-	-	-	-	1	1	2

Course Contents:

Student should undergo internship for 30 days in one stretch or 15 days in two stretches during or at the end of the 3rd semester. After completion, a report on internship to be submitted along with presentation which will be evaluated as per the university guidelines.

M20TI0302	Project Dissertation Phase-I	HC	L	T	P	C	Hrs /week
Duration:14 Wks			0	0	4	4	8

Prerequisites:

All previous courses taught in earlier semesters

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 successful completion of the course, the students 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.

BLOOM'S LEVELOF THECOURSE OUTCOMES:

CO	Bloom'sLevel					
	Remember (L1)	Understand (L2)	Apply (L3)	Analyze (L4)	Evaluate (L5)	Create (L6)
CO1		✓				
CO2				✓		

Mapping of Course Outcomes with Programme Outcomes

Course Code	POS/ COs	PO1	PO2	PO3	PO4	PO5	PO6	P7	PO8	PO9	PO 10	PO 11	PSO1	PSO2	PSO3
M20TI0302	CO1	2	1	3	3	2	3	3		1	3	3	1	1	2
	CO2	3	2	3	3	3	3	3		3	3	3	1	1	2

Course Contents:

The student 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.

M20TIS311	MOOC/SWAYAM	SC	L	T	P	C	Hrs /week
Duration:14 Wks	Online Course		4	0	0	4	4

Prerequisites:

All previous courses taught in earlier semesters

Course Objectives:

1. To provide an affordable and flexible way to learn new skills
2. To advance the career of students
3. To deliver quality educational experiences at scale

Course Outcomes:

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

1. Explain the fundamentals of the course learnt through an expert using online platform
2. Apply technology learnt to mechanical applications

BLOOM'S LEVELOF THECOURSE OUTCOMES:

CO	Bloom'sLevel					
	Remember (L1)	Understand (L2)	Apply (L3)	Analyze (L4)	Evaluate (L5)	Create (L6)
CO1		✓				
CO2			✓			

Mapping of Course Outcomes with Programme Outcomes

Course Code	POS/ COs	PO1	PO2	PO3	PO4	PO5	PO6	P7	PO8	PO9	PO 10	PO 11	PSO1	PSO2	PSO3
M20TIS311	CO1	2	1	1		2	3			1			1	1	1
	CO2	3	2	1		3	3			3			1	1	1

Course Contents:

Note: Students shall choose to take up any online course of three credits as guided by the school and the details of which are provided here under.

MOOC/ SWAYAM:

Globally, MOOC (Massive Open Online Course) platforms are gaining much popularity. Considering the popularity and relevance of MOOCs, Government of India has also launched an indigenous platform, SWAYAM. SWAYAM (Study Webs of Active Learning for Young Aspiring Minds) is basically an integrated MOOCs platform for distance education that is aimed at offering all the courses from school level (Class IX) to post-graduation level. The platform has been developed collaboratively by MHRD (Ministry of Human Resource Development) and AICTE (All India Council for Technical Education) with the help of Microsoft and is capable of hosting 2,000 courses.

A student shall register and successfully complete any of the courses available on SWAYAM.

Student shall inform the MOOC/SWAYAM coordinator of the school about the course to which he/she has enrolled. The minimum duration of the course shall be not less than 40 hours and of 4 credits. The student should submit the certificate issued by the SWAYAM to the MOOC/SWAYAM coordinator of the school, the grades obtained in the course shall be forwarded to concerned authority of the University.

List of some MOOC Centre:

1. Edx
2. Coursera
3. NPTEL
4. Swayam
5. Khan academy
6. Udacity
7. Udemy
8. Stanford online
9. WizIq

M20TIO301	Suitable On line Course of Interdisciplinary Nature	OE	L	T	P	C	Hrs /week
Duration:14 Wks			4	0	0	4	4

Prerequisites:

All previous courses taught in earlier semesters

Course Objectives:

1. To provide an affordable and flexible way to learn new skills of Interdisciplinary area
2. To advance the career
3. To deliver quality educational experiences at scale

Course Outcomes:

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

1. Explain the fundamentals of Interdisciplinary course learnt through an expert online
2. Apply technologies to solve engineering problems of Interdisciplinary nature

BLOOM'S LEVELOF THECOURSE OUTCOMES:

CO	Bloom'sLevel					
	Remember (L1)	Understand (L2)	Apply (L3)	Analyze (L4)	Evaluate (L5)	Create (L6)
CO1		✓				
CO2			✓			

Mapping of Course Outcomes with Programme Outcomes

Course Code	POS/ COs	PO1	PO2	PO3	PO4	PO5	PO6	P7	PO8	PO9	PO 10	PO 11	PSO1	PSO2	PSO3
M20TIO301	CO1	2	1	1		2	3		2	1			1	1	1
	CO2	3	2	1		3	3		3	3			1	1	1

Course Contents:

Note: Students shall choose to take up suitable online course of Interdisciplinary nature of three credits as guided by the school and the details of which are provided here under.

MOOC/ SWAYAM:

Globally, MOOC (Massive Open Online Course) platforms are gaining much popularity. Considering the popularity and relevance of MOOCs, Government of India has also launched an indigenous platform, SWAYAM. SWAYAM (Study Webs of Active Learning for Young Aspiring Minds) is basically an integrated MOOCs platform for distance education that is aimed at offering all the courses from school level (Class IX) to post-graduation level. The platform has been developed collaboratively by MHRD (Ministry of Human Resource Development) and AICTE (All India Council for Technical Education) with the help of Microsoft and is capable of hosting 2,000 courses.

A student shall register and successfully complete any of the courses available on SWAYAM.

Student shall inform the MOOC/SWAYAM coordinator of the school about the course to which he/she has enrolled. The minimum duration of the course shall be not less than 40 hours and of 4 credits. The student should submit the certificate issued by the SWAYAM to the MOOC/SWAYAM coordinator of the school, the grades obtained in the course shall be forwarded to concerned authority of the University.

List of some MOOC Centre:

1. Edx
2. Coursera
3. NPTEL
4. Swayam
5. Khan academy
6. Udacity
7. Udemy
8. Stanford online
9. WizIq

Fourth Semester:

M20TI0401	Master Thesis	HC	L	T	P	C	Hrs /week
Duration:14 Wks			0	0	16	16	32

Prerequisites:

All previous courses taught in earlier semesters

Course Objectives:

1. To identify the problem in real time application and find out the solution
2. To make the students to convert their ideas in to reality.
3. To develop the skill of writing, documentation and presentation.

Course Outcomes:

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

1. Identify the problems in the real time application.
2. Apply the knowledge to analyze the problem.
3. Document the progress of the work and results.
4. Design the process/ product for simple applications

BLOOM'S LEVELOF THECOURSE OUTCOMES:

CO	Bloom'sLevel					
	Remember (L1)	Understand (L2)	Apply (L3)	Analyze (L4)	Evaluate (L5)	Create (L6)
CO1		✓				
CO2			✓			
CO3				✓		
CO4						✓

Mapping of Course Outcomes with Programme Outcomes

Course Code	POS/ Cos	PO1	PO2	PO3	PO4	PO5	PO6	P07	PO8	PO9	PO 10	PO 11	PSO1	PSO2	PSO3
M20TI0401	**CO1**	**2**	**2**	**3**	**2**	**2**	**2**	**2**	**3**	**2**	**3**	**3**	3	2	**3**
	CO2	**3**	**2**	**2**	**3**	**3**	2	**2**	**3**	**2**	**3**	**3**	2	1	**3**
	CO3	**3**	**2**	**2**	**3**	**3**	**2**	**1**	**3**	**2**	**3**	**3**	2	1	**3**
	CO4	**3**	**2**	**2**	**3**	**3**	**2**	**1**	**3**	**2**	**3**	**3**	2	1	**3**

Course Contents:

The student has to continue the project which he has started in 3rd Semester from an industry or in the society or any innovative ideas. Student has to work for the solution or converting their ideas into product and present the progress of the work in two phases which will be evaluated. 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 and vivo-voce will be conducted for each student.