RAMAIAH
Institute of Technology

CURRICULUM

Academic Year 2026 – 2027

V & VI SEMESTER
B.E: MECHANICAL ENGINEERING
Batch 2024

RAMAIAH INSTITUTE OF TECHNOLOGY
(Autonomous Institute, Affiliated to VTU)
Approved by AICTE, New Delhi and Govt. of Karnataka
Accredited by NBA&NAAC with A^+ Grade

About the Institute

In 1962, Dr. M. S. Ramaiah, a visionary philanthropist, established the Gokula Education Foundation with a noble mission to uplift society through education. The same year marked a pivotal moment in technical education in India with the founding of the M S Ramaiah Institute of Technology (MSRIT).

MSRIT offers an impressive array of 18 undergraduate and 15 postgraduate programs, all approved by the All India Council for Technical Education (AICTE). The National Board of Accreditation (NBA) has accredited all eligible programs at the undergraduate (UG) and postgraduate (PG) levels. In March 2021, MSRIT earned an 'A^{+}' grade from the National Assessment and Accreditation Council (NAAC), underscoring its unwavering commitment to academic excellence. Since 2007, the institute has proudly held Autonomous Status for its UG and PG programs, a prestigious recognition granted by the University Grants Commission (UGC) and Visvesvaraya Technological University (VTU). According to the Ministry of Education, Government of India's NIRF Ranking Framework, MSRIT ranks 75th among 1,584 leading engineering institutions and 31st among 131 architecture schools in India for 2025, highlighting its remarkable impact and leadership in education.

The institute participated in the Technical Education Quality Improvement Program (TEQIP), an initiative of the Government of India. To foster a research culture, the institute has established several specialized centres, including the Centre for Imaging Technologies, the Centre for Advanced Materials Technology, the Centre for Antennas and Radio Frequency Systems (CARFS), the Centre for Cyber Physical Systems, the Schneider Centre of Excellence, the Centre for Bio and Energy Materials Innovation, JSW Centre of Excellence in Power Systems and more. MSRIT boasts a faculty of 380 highly qualified members, 70% of whom hold doctoral degrees, and over 300 scholars currently pursuing Ph.D. degrees.

The Entrepreneurship Development Cell (EDC) and "Ramaiah Evolute" have been established on campus to support startup incubation. MSRIT features a dedicated Placement and Training department, a strong mentoring and proctorial system, a fully equipped sports department, and a spacious, air-conditioned library with a wide range of books and subscriptions to both international and national journals. The Digital Library provides access to online e-journals from renowned publishers, including Elsevier ScienceDirect, IEEE, Taylor & Francis, Springer Nature and Emerald. Additionally, the Institute is a member of DELNET, JRD Tata Memorial library, IISc, and the VTU Consortium for E-Resources.

The institute features a state-of-the-art auditorium, a well-equipped recording studio, and multiple advanced conference halls with videoconferencing capabilities. Additionally, MSRIT provides excellent hostel accommodations for both boys and girls, ensuring a comfortable living environment. MSRIT alumni have achieved remarkable success, holding prominent positions in India and internationally. They maintain strong connections with the institute through an engaged and active Alumni Association.

Founded on Dr. Ramaiah's unwavering commitment to knowledge and innovation, this remarkable institution continues to inspire generations of students and shape the future of engineering and technology in the country.

About the Department:

The Department of Mechanical Engineering started in the year 1962 with an intake of 40 students. The department has grown strong over the last 63 years and today has an intake of 120 students and 32 teaching staff. All the faculty members are well qualified and possess post graduate degree with 26 doctorates. The department offers four-year degree course and offers one Master Degree in Robotics and Artificial Intelligence, with an intake of 18. The Department also offers research program which includes MSc Engineering by research and PhD degree from Visvesvaraya Technological University. The faculty members have taken up number of research projects funded by external agencies like DRDO, DST, AICTE, IIT Indore, SERB, VGST and Visvesvaraya Technological University and received funding more than Rs 1.4 Crores. The department has exemplified its dedication to scholarly advancement by organizing a national-level project exhibition and convening esteemed international conferences, including the International Conference on Recent Advances in Engineering Sciences (ICRAES) and the International Conference on Mechanics of Advanced Materials and Structures (ICMAMS). These initiatives have served as pivotal forums for intellectual discourse, fostering innovation and facilitating the dissemination of cutting-edge research within the academic community. Faculty members from the department have published books on different domains of Mechanical Engineering and are recommended by Visvesvaraya Technological University Board of Studies as reference text books.
The department consistently fosters and facilitates student participation in technical competitions and projects to advance their academic expertise and professional development.
Team EDITHA participated in the Student Unmanned Aerial System (SUAS) competition held in Maryland, California, USA, from June 24th to 26th, 2025. The team distinguished itself by securing an overall fourth place, accompanied by a prize award of USD 1,000, as well as achieving third place in the technical design report category.
The department has achieved significant recognition through its team, CO2 - Velocita Racing, at the Formula Bharat 2025 competition held at Kari Motor Speedway, Coimbatore, from January 22 to 27, 2025. The team secured an overall 2nd place in the combustion category, demonstrating excellence across multiple events including Engineering Design (2nd place), Acceleration (winner), Autocross (winner), and Skidpad (winner). Their outstanding performance earned them a total overall score of 538.41 points with no penalties, reflecting their technical expertise and innovative engineering capabilities. This achievement underscores the department’s commitment to fostering high-level competitive skills, practical engineering application, and collaborative innovation among its students.

VISION OF THE INSTITUTE

To be an Institution of International Eminence, renowned for imparting quality technical education, cutting edge research and innovation to meet global socio-economic needs.

MISSION OF THE INSTITUTE

MSRIT shall meet the global socio-economic needs through

1. Imparting quality technical education by nurturing a conducive learning environment through continuous improvement and customization
2. Establishing research clusters in emerging areas in collaboration with globally reputed organizations
3. Establishing innovative skills development, techno-entrepreneurial activities and consultancy for socio-economic needs

QUALITY POLICY

We at M S Ramaiah Institute of Technology strive to deliver comprehensive, continually enhanced, global quality technical and management education through an established Quality Management System complemented by the synergistic interaction of the stake holders concerned

VISION OF THE DEPARTMENT

To be a centre of international repute in Mechanical Engineering and to create qualified human resources needed to meet the demanding challenges in different areas and emerging fields of Mechanical Engineering and allied sciences.

MISSION OF THE DEPARTMENT

To impart quality technical education to meet the growing needs of the profession through conducive and creative learning environment, to produce qualified and skilled human resources, create R&D environment, to be a centre of excellence and to offer post graduate programs in the emerging fields of Mechanical Engineering.

Program Educational Objectives (PEOs):

1) To produce engineers with sound basic theoretical knowledge along with required practical skills in various specialized fields of Mechanical Engineering.

2) To inculcate team work capabilities and communication skills among students through co-curricular activities.

3) To motivate students for higher studies in specialized areas of Mechanical Engineering and explore possible profession in R & D, academic and self-employment opportunities.

4) To bring in awareness on environmental issues and commitments towards Professional ethics, social responsibilities and need for lifelong learning.

Knowledge and Attitude Profile (WK)

WK1: A systematic, theory-based understanding of the natural sciences applicable to the discipline and awareness of relevant social sciences.

WK2: Conceptually-based mathematics, numerical analysis, data analysis, statistics and formal aspects of computer and information science to support detailed analysis and modelling applicable to the discipline.

WK3: A systematic, theory-based formulation of engineering fundamentals required in the engineering discipline.

WK4: Engineering specialist knowledge that provides theoretical frameworks and bodies of knowledge for the accepted practice areas in the engineering discipline; much is at the forefront of the discipline.

WK5: Knowledge, including efficient resource use, environmental impacts, whole-life cost, reuse of resources, net zero carbon, and similar concepts, that supports engineering design and operations in a practice area.

WK6: Knowledge of engineering practice (technology) in the practice areas in the engineering discipline.

WK7: Knowledge of the role of engineering in society and identified issues in engineering practice in the discipline, such as the professional responsibility of an engineer to public safety and sustainable development.

WK8: Engagement with selected knowledge in the current research literature of the discipline, awareness of the power of critical thinking and creative approaches to evaluate emerging issues.

WK9: Ethics, inclusive behavior and conduct. Knowledge of professional ethics, responsibilities, and norms of engineering practice. Awareness of the need for diversity by reason of ethnicity, gender, age, physical ability etc. with mutual understanding and respect, and of inclusive attitudes.

PROGRAM OUTCOMES (POs):

PO1: Engineering knowledge: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and in engineering specialization as specified in WK1 to WK4 respectively to develop to the solution of complex engineering problems.

PO2: Problem analysis: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development. (WK1 to WK4)

PO3: Design/Development of solutions: Design c r e a t i v e solutions for complex engineering problems and design/develop systems/ components/ processes to meet identified needs with consideration for the public health and safety, whole-life cost,net zero carbon ,culture, society and environment as required.(WK5)

PO4: Conduct investigations of complex problems: Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions. (WK8)

PO5: Engineering tool usage: Create, select, and apply appropriate techniques, resources, and modern engineering & IT tools, including prediction and modeling recognizing their limitations to solve complex engineering problems. (WK2 and WK6)

PO6: The engineer and the world: Analyze and evaluate societal and environmental aspects while solving complex engineering problems for its impact on sustainability with reference to economy, health, safety, legal frame work, culture and environment. (WK1, WK5, and WK7)

PO7: Ethics: Apply ethical principles and commit to professional ethics, human values, diversity and inclusion; adhere to national and international laws. (WK9)

PO8: Individual and collaborative Team work: Function effectively as an individual, and as a member or leader in diverse/multi-disciplinary teams.

PO9: Communication: Communicate effectively and inclusively within the engineering community and society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations considering cultural, language, and learning differences.

PO10: Project management and finance: Apply knowledge and understanding of engineering management principles and economic decision-making and apply these to one's own work, as a member and leader in a team, and to manage projects and in multi-disciplinary environments.

PO11: Life-long learning: Recognize the need for, and have the preparation and ability for i) independent and life-long learning ii) adaptability to new and emerging technologies and iii) critical thinking in the broadest context of technological change. (WK8)

PSOs of the program offered:

Mechanical Engineering Graduates will be able to:

PSO1: Ability to apply their knowledge in engineering mechanics, materials science, design, thermal engineering, production, management, CAD/CAM, robotics - on an applied basis.

PSO2: Ability to apply the learned principles to the analysis, design, development and implementation to advanced mechanical systems and processes, be prepared to work professionally in Mechanical Engineering domain.

UG Curriculum Course Credits

Batch- 2024 (ME-Stream)

Semester / Course Category	First	Second	Third	Fourth	Fifth	Sixth	Seventh	Eighth	Total Credits
Basic Science Course (BSC)	08	08	03	03	---	---	---	---	**22**
Engineering Science Courses(ESC/ PLC/ETC)	08	09	---	---	---	---	---	---	**17**
Humanities, Social Sciences and Management (HSMC)	02	02	---	---	03	03	---	---	**10**
Ability Enhancement Course (AEC)	02	01	01	01	01	---	---	---	**06**
Skill Development Course (SDC)	---	---	---	---	---	01	02	---	**03**
Universal Human Values (UHV)	---	---	02	---	---	---	---	---	**02**
Professional Courses Core (PCC)	---	---	11	12	12	06	04	---	**45**
Integrated Professional Core Course (IPCC)	---	---	04	04	03	---	04	---	**15**
Professional Electives Courses - (PEC)	---	---	---	---	03	06	03	---	**12**
Open Elective Courses (OEC)	---	---	---	---	---	03	03	---	**06**
Internship (INT)	---	---	---	---	---	---	---	05	**05**
Mini Project/ Project Work(PW)	---	---	---	---	---	04	---	13	**17**
Non Credit Mandatory Courses (NCMC)	---	---	---	Yes	Yes	Yes	---	---	**---**
Total Credits	**20**	**20**	**21**	**20**	**22**	**23**	**16**	**18**	**160**

B.E. in Mechanical Engineering
SCHEME OF TEACHING
Batch 2024

V SEMESTER

Sl. No	Subject Code	Subject	Teaching Department	Category	Credits				Total contact hours / week			
					L	T	P	Total	L	T	P	S
1	ME51	Heat Transfer	Mechanical	PCC	2	1	0	3	2	2	0	2
2	ME52	Theory of Machines	Mechanical	PCC(IC)	2	0	1	3	2	0	2	2
3	ME53	Fluid Mechanics & Machinery	Mechanical	PCC	2	1	0	3	2	2	0	2
4	ME54	Machine Design-II	Mechanical	PCC	3	1	0	4	3	2	0	3
5	MEE55x	Program Elective Course – 1	Mechanical	PEC	3	0	0	3	3	0	0	3
6	MEL56	Turbo machinery Laboratory	Mechanical	PCC	0	0	1	1	0	0	2	0
7	MEL57	Design and Dynamics Laboratory	Mechanical	PCC	0	0	1	1	0	0	2	0
8	AL58	Research Methodology & Intellectual property rights	Mechanical	PCC	3	0	0	3	3	0	0	3
9	MEAEC59	Ability Enhancement Course - V	Mechanical	AEC	1	0	0	1	1	0	0	1
				Total	**16**	**3**	**3**	**22**	**16**	**6**	**6**	**16**
10	HS510	Environmental Studies *****	Civil	NCMC	0	0	0	0	-			

* Ability Enhancement Course-V: **Geometric Dimensioning and Tolerancing for Mechanical Design**
* Environmental Studies is under the category of NCMC, 1 hour teaching per week has to be allocated in the time table.

NOTE: Minimum of 1 subject should have a Tutorial component of 1 Credit.

Nomenclature: IC: Integrated Course (Practical Integrated with Theory Course), **PCC:** Professional Core Course, **PEC:** Professional Elective Course, **AEC:** Ability Enhancement Course, **NCMC:** Non-credit Mandatory Course

Credit Definition:

- **1 credit = 1 hour/week of lecture (L)**
- **1 credit = 2 hours/week of tutorial (T)**
- **1 credit = 2 hours/week of practical(P)**
- **Self-Learning Hours (S)**

Note: XXE55x, where x=1,2,3,4,5

PCC(IC) is an Integrated course, combining theory with practical components.

- Theory sessions shall be conducted for 3 hours per week, while the practical sessions shall be conducted for 2 hours per week.
- Theory components shall be evaluated through both Continuous Internal Evaluation (CIE) and Semester End Examination (SEE).
- The practical component shall be assessed only through CIE (No SEE).
- The CIE shall consist of two internal test of 30 marks each. Each test will have three questions and student shall answer any two full questions. Each question shall have all CO's addressed for that test. An average of two test shall be taken to award 30 marks.
- The CIE for the practical component shall be evaluated for 20 marks. Each laboratory experiment shall be evaluated for 10 marks based on the experiment record, conduction of the experiment, and observations, and the cumulative marks shall be scaled down to 15 marks. Another 05 marks from a lab test and viva.
- The SEE shall be evaluated for 100 marks, which shall be scaled down to 50 marks.
- The SEE examination shall consist of 10 questions with internal choice and student shall answer any five full questions.
- However, questions from the practical component of the Integrated course (IC) can be included in the SEE question paper.

PCC & PEC courses are theory courses with or without tutorial sessions.

- Each theory credit corresponds to one contact hour per week, while each tutorial credit corresponds to two contact hours per week.
- The course shall be evaluated through Continuous Internal Evaluation (CIE) and Semester End Examination (SEE), each having a weightage of 50%.
- The CIE is evaluated for 50 marks through internal tests (30 marks) and other components (20 marks). Each internal test will have three questions and students shall answer any two full questions. Each question shall address all the Course Outcomes (COs) prescribed for that test. The average of the two tests shall be considered for awarding 30 marks. The remaining 20 marks shall be assessed through assignments, tutorial tests, quizzes, surprise tests, mini-projects, or other components as decided by the course instructor.
- The SEE shall be evaluated for 100 marks, which shall be scaled down to 50 marks.
- The SEE examination shall consist of ten questions with internal choice (two questions per unit). Students shall answer any five full questions, selecting at least one question from each unit.

NOTE: Professional Elective Courses shall have minimum students' strength for offering open electives as 10. However, this condition shall not be applicable to cases where the admission to the program is less than 10.

AEC is a 1-credit course involving 1 contact hour per week. The course shall be evaluated through Continuous Internal Evaluation (CIE) and Semester End Examination (SEE), each having a weightage of 50%.

- The CIE will comprise of two tests of 30 marks each having Part-A with MCQs for 6 marks and Part-B with Descriptive questions. The remaining 20 marks shall be assessed through assignments, surprise tests, quizzes, or other components as decided by the course instructor.
- The SEE will comprise of Part-A with MCQs (10 marks) and Part-B (5x8=40 marks) with descriptive questions.

PCC Laboratory is a 1-credit lab course involving 2 hours of lab sessions per week and uses both Continuous Internal Evaluation (CIE) and Semester End Examination (SEE) for assessment.

- CIE totals 50 marks, with 30 marks for lab sessions (Each laboratory experiment shall be evaluated for 10 marks based on the experiment record, conduction of the experiment, and observations, and the cumulative marks shall be scaled down to 30 marks.). Another 15 marks from a lab test and 05

marks for viva.

- SEE totals 50 marks, comprising 40 marks for procedure write up, experiment conduction & results and 10 marks for viva voce.

AICTE Activity Points Requirement for BE Programs: As per AICTE guidelines (refer Chapter 6 – *AICTE Activity Point Program, Model Internship Guidelines*), in addition to academic requirements, students must earn a specified number of **Activity Points** to be eligible for the award of the degree. The points to be earned is:

1. **Regular students** admitted to a 4-year degree program must earn **100 Activity Points**.
2. **Lateral entry students** (joining from the second year) must earn **75 Activity Points**.
3. **Students transferred** from other universities directly into the V semester must earn **50 Activity Points** from the date of entry into VTU.

These Activity Points are non-credit and will not be considered for the SGPA/CGPA or be used for vertical progression. However, earning Activity Points is mandatory for the award of the degree, and the points earned will be reflected on the eighth semester Grade Card. If a student completes all the semesters (eight or six) at the end of the program but fails to earn the required Activity Points, the VIII semester Grade Card will be withheld until the requirement is fulfilled. Also, the degree will be awarded only after the Grade Card has been released. The hours spent earning the activity points will not be counted for regular attendance requirements. Students can accumulate these points at any time during their program period, including weekends, holidays, and vacations, starting from the year of admission, provided they meet the minimum hours of engagement prescribed for each activity by AICTE.

The Non-Credit Mandatory Course, Environmental Studies: The students shall attend classes for the course during the semester and complete all formalities of attendance and CIE. In case, any student fails to secure the minimum 40% of the prescribed CIE marks, he/she shall be deemed to have secured **'F'** grade. In such a case, the student has to fulfill the requirements during subsequent semester/s to appear for CIE. This Course shall not be considered for vertical progression, but completion of the course shall be mandatory for the award of the degree.

LIST OF COURSES OFFERED UNDER PROGRAM ELECTIVE COURSE -1 CREDITS: 3:0:0

Sl. No.	Subject Code	Subject
1	MEE551	Mechatronics & MEMS
2	MEE552	Hydraulics & Pneumatic
3	MEE553	Composite Materials
4	MEE554	Additive Manufacturing
5	MEE555	Electric Vehicle Technology
6	MEE556	Theory of Elasticity
7	MEE557	Industrial Design and Ergonomics
8	MEE558	Refrigeration and Advanced Cooling Techniques

B.E. in Mechanical Engineering
SCHEME OF TEACHING
Batch 2024

VI SEMESTER

Sl. No.	Subject Code	Subject	Teaching Department	Category	Credits				Total contact hours /Week			
					L	T	P	Total	L	T	P	S
1	AL61	Management & Entrepreneurship	Mechanical	HSMC	3	0	0	3	3	0	0	3
2	ME62	Finite Element Analysis	Mechanical	PCC	3	1	0	4	3	2	0	3
3	MEE63x	Program Elective Course – 2	Mechanical	PEC	3	0	0	3	3	0	0	3
4	MEE64x	Program Elective Course – 3	Mechanical	PEC	3	0	0	3	3	0	0	3
5	MEL65	Finite Element Analysis Laboratory	Mechanical	PCC	0	0	1	1	0	0	2	0
6	MEL66	Heat Transfer Laboratory	Mechanical	PCC	0	0	1	1	0	0	2	0
7	MEOE0x*	Institutional Open Elective - 1	Mechanical	OEC	3	0	0	3	3	0	0	3
8	MEP67	Mini Project	Mechanical	PW	0	0	4	4	-	-	-	-
9	ME68	Technical Skill Enhancement Course	Industry Expert	SDC	0	1	0	1	0	2	0	0
				Total	**15**	**2**	**6**	**23**	**15**	**4**	**4**	**15**
10	PE69	Physical Education		**NCMC**	All students have to register compulsorily for any one of the courses with the concerned coordinator (Yoga Teacher/ Physical Education Director/ NSS Coordinator) in the beginning of the III semester. Attending the registered course from III to VI semesters. Successful completion of the registered course and requisite CIE score is mandatory for the award of the degree.							
	YO69	Yoga										
	NS69	NSS										

LIST OF COURSES OFFERED UNDER PROGRAM ELECTIVE COURSE –2CREDITS: 3:0:0

Sl. No.	Subject Code	Subject
1.	MEE631	Robotics
2.	MEE632	CNC Machines
3.	MEE633	Total Quality Management
4.	MEE634	Engineering Economy

LIST OF COURSES OFFERED UNDER PROGRAM ELECTIVE COURSE –3 CREDITS: 3:0:0

Sl. No.	Subject Code	Subject
1	MEE641	Operations Research
2	MEE642	Computational Fluid Dynamics
3	MEE643	Nano Technology
4	MEE644	Non-Traditional Machining
5	MEE645	Basic to Machine Learning & Python
6	MEE 646	HVAC and thermal systems engineering

LIST OF COURSES OFFERED UNDER OPEN ELECTIVE COURSE –1 CREDITS: 3:0:0

Sl. No.	Subject Code	Subject
1	MEOE01	3D Printing
2	MEOE02	CNC Machines
3	MEOE03	Sustainable Waste Management Techniques
4	MEOE04	Traditional Indian Science and Technology
5	MEOE05	Automotive Engineering
6	MEOE11	Additive Manufacturing

NOTE: Minimum of 1 subject should have a Tutorial component of 1 Credit.

Nomenclature- PCC: Professional Core Course**, PEC:** Professional Elective Courses, **OEC:** Open Elective Course, **PW:** Mini Project, **SDC:** Skill Development Course, **NCMC:** Non-credit Mandatory Course, **INT:** Internship

Credit Definition:

- **1 credit = 1 hour/week of lecture (L)**
- **1 credit = 2 hours/week of tutorial (T)**
- **1 credit = 2 hours/week of practical(P)**
- **Self-Learning Hours (S)**

Note: XXE63x, where x=1,2,3,4,5

PCC & PEC & HSMC courses are theory courses with or without tutorial sessions.

- Each theory credit corresponds to one contact hour per week, while each tutorial credit corresponds to two contact hours per week.
- The course shall be evaluated through Continuous Internal Evaluation (CIE) and Semester End Examination (SEE), each having a weightage of 50%.
- The CIE is evaluated for 50 marks through internal tests (30 marks) and other components (20 marks). Each internal test will have three questions and students shall answer any two full questions. Each question shall address all the Course Outcomes (COs) prescribed for that test. The average of the two tests shall be considered for awarding 30 marks. The remaining 20 marks shall be assessed through assignments, tutorial tests, quizzes, surprise tests, mini-projects, or other components as decided by the course instructor.
- The SEE shall be evaluated for 100 marks, which shall be scaled down to 50 marks.
- The SEE examination shall consist of ten questions with internal choice (two questions per unit). Students shall answer any five full questions, selecting at least one question from each unit.

NOTE: Professional Elective Courses shall have minimum students' strength for offering open electives as 10. However, this condition shall not be applicable to cases where the admission to the program is less than 10.

PCC Laboratory is a 1-credit lab course involving 2 hours of lab sessions per week and uses both Continuous Internal Evaluation (CIE) and Semester End Examination (SEE) for assessment.

- CIE totals 50 marks, with 30 marks for lab sessions (Each laboratory experiment shall be evaluated for 10 marks based on the experiment record, conduction of the experiment, and observations, and the cumulative marks shall be scaled down to 30 marks.). Another 15 marks from a lab test and 05 marks for viva.
- SEE totals 50 marks, comprising 40 marks for procedure write up, experiment conduction & results and 10 marks for viva voce.

Open Elective Courses:

Students belonging to a particular stream of Engineering and Technology are not entitled for the open electives offered by their parent department. However, they can take an elective offered by other departments, provided they satisfy the prerequisite condition, if any. Registration to open electives shall be documented under the guidance of the Program Coordinator/ Advisor/Mentor.

Selection of an open elective shall not be allowed if,

1. The candidate has studied the same course during the previous semesters of the program.
2. The syllabus content of open electives is similar to that of the Departmental core courses or professional electives.
3. A similar course, under any category, is prescribed in the higher semesters of the program.
4. The minimum students' strength for offering open electives is 10. However, this condition shall not be applicable to cases where the admission to the program is less than 10.

Mini-project work: Mini Project is a laboratory-oriented course which will provide a platform to students to enhance their practical knowledge and skills by the development of small systems/applications.

Based on the ability/abilities of the student/s and recommendations of the mentor, a single discipline or a multidisciplinary Mini- project can be assigned to an individual student or to a group having not more than 4 students.

CIE procedure for Mini-project:

(i) Single discipline: The CIE marks shall be awarded by a committee consisting of the Head of the concerned Department and two faculty members of the Department, one of them being the Guide. The CIE marks awarded for the Mini-project work shall be based on the evaluation of project report, project

presentation skill, and question and answer session as per the rubrics defined by the department.

(ii) Interdisciplinary: Continuous Internal Evaluation shall be group-wise at the college level with the participation of all the guides of the project.

The CIE marks awarded for the Mini-project, shall be based on the evaluation of project report, project presentation skill, and question and answer session as per the rubrics defined by the parent department.

SEE component for Mini-Project: SEE will be conducted by the two examiners appointed by the Institute. SEE marks awarded for the mini project shall be based on the evaluation of project work report, project presentation skill and question and answer session.

Technical Skill Enhancement Course: is a 1-credit tutorial course with 2 contact hours per week. This course is designed to improve the practical and technical skills of students, focusing on developing industry-relevant and job-oriented skills, and enhance employability of the students. The course teacher shall be an industry expert who provides hands-on experience with relevant tools and technologies currently existing in the industry. The students shall attend classes for the course during the semester and complete all formalities of attendance and CIE. The course shall be evaluated by the industry expert through Continuous Internal Evaluation (CIE) for 100 marks.

Non-Credit Mandatory Course: The students shall attend classes for the course during the semester and complete all formalities of attendance and CIE. In case, any student fails to secure the minimum 40% of the prescribed CIE marks, he/she shall be deemed to have secured **'F'** grade. In such a case, the student has to fulfill the requirements during subsequent semester/s to appear for CIE. This Course shall not be considered for vertical progression, but completion of the course shall be mandatory for the award of the degree.

AICTE Activity Points to be earned by students admitted to BE program (For more details refer to Chapter 6, AICTE, Activity Point Program, Model Internship Guidelines):

Every regular student, who is admitted to the 4-year degree program, is required to earn 100 activity points in addition to the total credits earned for the program. Students entering 4 years' degree program through lateral entry are required to earn 75 activity points in addition to the total credits earned for the program. The activity points earned by the student shall be reflected on the students VIII semester grade card. The activities to earn the points can be spread over the duration of the course. However, minimum prescribed duration should be fulfilled. Activity points (non-credit) have no effect on SGPA/CGPA and shall not be considered for vertical progression. Incase student fail to earn the prescribed activity points; 8^{th} semester grade card shall be issued only after earning the required activity Points. Students shall be eligible for the award of degree only after the release of the VIII semester grade card.

Note: Internship: All the students shall have to undergo mandatory internship of 6 – 8 weeks during the intervening vacation of the IV & V semesters, intervening vacation of VI & VII semesters, VII semester. A Viva-voce based CIE examination shall be conducted during the VIII semester as per the rubrics defined by the department and the prescribed credits shall be included in VIII semester grade card.

V SEMESTER

HEAT TRANSFER	
Course Code: ME51	**Credits: 2:1:0**
Pre – requisites: Nil	**Contact Hours: 30L+30T+30S**
Course Coordinator: Dr. Niranjan Murthy	

Course Content

Unit I

Introductory concepts: Modes of Heat Transfer, Basic Laws of Heat Transfer, Overall Heat Transfer Coefficient, Boundary Conditions, 3-D Conduction Equation in Cartesian coordinates, 1-D Conduction equations in Cartesian, Cylindrical and Spherical Coordinate Systems. Composite Walls, Cylinders and Spherical Systems with Constant Thermal Conductivity, Numerical Problems.

- Pedagogy/Course delivery tools: Chalk and talk, animated videos
- Lab component/ Practical topics: Conductivity of metal rod, composite wall
- Links: Fundamental of Heat Transfer: https://www.youtube.com/watch?v=TWTQx3W-2k8&list=PLZOZfX_TaWAE6nTX50dJl0Jia8iQTIhrG
- Links: Fundamentals of Heat Transfer: https://www.youtube.com/watch?v=Bz9HpxY64F8

Unit II

Variable thermal Conductivity: Derivation for 1-D heat flow and temperature distribution in plane wall, cylinder, sphere with variable thermal conductivity. Insulating materials and their selection, critical thickness of insulation.

Heat transfer in extended surfaces: Derivation for 1-D heat flow and temperature distribution in straight fin with end conditions such as, infinitely long fin, fin with insulated tip, fin with convection at the tip and fin connected between two heat sources. Fin efficiency and effectiveness, 1-D numerical method for fin. Numerical problems.

- Pedagogy/ Course: delivery tools: Chalk and talk, Power point presentation, animated videos
- Lab component/ Practical topics: Pin Fin Experiment
- Links: Critical thickness of Insulation https://www.youtube.com/watch?v=vBx8bm14Ui8
- Links: Fins https://www.youtube.com/watch?v=5dL_cSYRxLM

Unit III

Concepts and basic relations in boundary layers: Hydrodynamic and thermal boundary layers, critical Reynolds number, local heat transfer coefficient, average heat transfer coefficient, Flow inside a duct, hydrodynamic and thermal entrance lengths.

Natural or Free convection: Application of dimensional analysis for free convection. Physical significance of Grasshoff number, Rayleigh number. Use of correlations in free convection for horizontal, vertical plates and cylinders. Numerical problems

Forced convection heat transfer: Application of dimensional analysis for forced convection. Physical significance of Reynolds, Prandtl, Nusselt and Stanton numbers. Use of correlations for hydro-dynamically and thermally developed flows in case of a flow through tubes, flow over a flat plate and cylinder. Numerical problems.

- ∉ Pedagogy/ Course delivery tools: Chalk and talk, Power point presentation, animated videos
- ∉ Lab component/ Practical topics: Determination of heat transfer co-efficient in natural and forced convection heat transfer
- ∉ Links: Hydrodynamic boundary layer concept https://www.youtube.com/watch?v=QvplhLUiM9U
- ∉ Links: Convection heat transfer problems https://www.youtube.com/watch?v=P2eN2EApGEY

Unit IV

Heat exchangers: Classification of heat exchangers, Tubular and compact heat exchangers, overall heat transfer coefficient, fouling factor, L.M.T.D method, effectiveness, NTU method of analysis of heat exchangers, Numerical problems.

Condensation and Boiling heat transfer: Types of condensation, Nusselt's theory for laminar condensation on a vertical flat surface, expression for film thickness and heat transfer coefficient, Numerical problems.

- ∉ Pedagogy/Course delivery tools: Chalk and talk, Power point presentation, animated videos
- ∉ Lab component/Practical topics: Parallel and Counter flow Heat Exchangers
- ∉ Links: Parallel and Counter flow heat exchangers https://www.youtube.com/watch?v=tfdm5-t6uRs
- ∉ Links: Boiling and Condensation https://www.youtube.com/watch?v=yJKWLDD6ZQM

Unit V

Radiation heat transfer: Thermal radiation, definitions of various terms used in radiation heat transfer, Stefan-Boltzman law, Kirchoff`s law, Planck`s law and Wein`s displacement law, Radiation heat exchange between two parallel infinite black surfaces and gray surfaces, effect of radiation, shield, Intensity of radiation and solid angle, Lambert`s law, radiation heat exchange between two infinite surfaces, Radiation shape factor, Numerical problems**.**

- ∉ Pedagogy/ Course delivery tools: Chalk and talk, Power point presentation, animated videos
- ∉ Lab component/ Practical topics: Determination of Stefan-Boltzman constant
- ∉ Links: Radiation heat transfer https://www.youtube.com/watch?v=3bAEipA5ZpI
- ∉ Links: Basic concepts and definitions of radiation https://www.youtube.com/watch?v=93WjziMwkmQ

Text Books:

1. Heat and Mass Transfer, S.C. Sachdev, New Age International Edition. ,2006.,
2. Basic Heat Transfer, OZISIK, McGraw-Hill publications, NY. 2005.,
3. Heat and Mass Transfer, M.Thirumaleshwar, Pearson Edition. 2006.,
4. Heat and Mass Transfer Data book, C. P Kothandaraman & S.Subramanyan, New age International(P) limited publishers, 2007

Reference Books:

1. Heat Transfer, a practical approach. Yunus A Cenegal, Tata McGraw-Hill publishers, NY. 2001.
2. Heat Transfer, J.P Holmon, McGraw-Hill Publishers special Indian edition 2011.
3. Principles of Engineering Heat Transfer, Krieth F, Thomas learning. 2001.

Web links and video lectures (e-Resources)

1. https://www.youtube.com/watch?v=TWTQx3W-k8&list=PLZOZfX_TaWAE6nTX50dJl0Jia8iQTIhrG
2. https://nptel.ac.in/courses/108/106/108106170/
3. https://www.youtube.com/watch?v=5dL_cSYRxLM
4. https://www.youtube.com/watch?v=QvplhLUiM9U
5. https://www.youtube.com/watch?v=o72FpcKJK_Q
6. https://www.youtube.com/watch?v=3bAEipA5ZpI

Course Outcomes (COs):

After studying the course, the student is able to:

1. Analyze and calculate one dimensional steady state conduction heat transfer through plane wall, cylinder, sphere of uniform and non-uniform thermal conductivity with and without heat generation. (PO 1, PO2, PO3, PO4, PO5, PO11, PSO1, PSO2)
2. Determine temperature and heat flow from straight fins subjected to different boundary conditions and analyzes unsteady state conduction problems with lumped analysis and using Heisler charts. (PO 1, PO2, PO3, PO5, PO6, PO11, PSO1, PSO2)
3. Demonstrate the evaluation of convective heat transfer in free and forced convection from walls, cylinder etc. under different conditions. (PO 1, PO2, PO3, PO5, PO6, PO11, PSO1, PSO2)
4. Do thermal design of heat exchangers using LMTD and NTU methods and also demonstrate the heat transfer with change of phase that is boiling and condensation. (PO 1, PO2, PO3, PO4, PO5, PO6, PO9, PO10, PO11, PSO1, PSO2)
5. Workout the radiation heat transfer problems for different cases including radiation shield and solve simple numericals. (PO 1, PO2, PO3, PO5, PO6, PO11, PSO1, PSO2)

Course Assessment and Evaluation

Continuous Internal Evaluation (CIE): 50 Marks		
Assessment tool	**Marks**	**Course outcomes addressed**
Internal test-I	30	CO1 &CO2
Internal test-II	30	CO3, CO4 & CO5
The average of the two internal tests will be considered for evaluation of 30 Marks		
Other components- 20 Marks		
Assignment	10	CO1, CO2, CO3
Quiz/Surprise test	10	CO4 & CO5
Semester End Examination (SEE) - 100 Marks		
Semester End Examination	100	CO1, CO2, CO3, CO4 & CO5

THEORY OF MACHINES	
Course Code: ME52	**Credits: 2:0:1**
Pre – requisites: Nil	**Contact Hours: 30L+30P+30S**
Course Coordinator: Deepak S & Pradeep Kumar K V	

Course Content

Unit I

Introduction: Definitions of link or element, kinematic pairs, degrees of freedom, Grubler's criterion (without derivation), kinematic chain, mechanism, structure, mobility of mechanism, inversion, machine, kinematic chains and inversions. Inversions of four bar chain, single slider crank chain and double slider crank chain.

Mechanisms: Quick return motion mechanisms – drag link mechanism, straight line motion mechanisms – Peaucellier's mechanism and Robert's mechanism.

- Pedagogy/Course delivery tools: Chalk and talk, Powerpoint presentation, animated videos
- Links: Kinematic chain https://www.youtube.com/watch?v=gaj_cuZvHg0
- Links: Quick return mechanism https://www.youtube.com/watch?v=s3G3au-EyAQ
- Laboratory session: Position analysis of Grashof four bar Mechanism, Slider Crank Mechanism, whitworth Mechanism

Unit II

Velocity and Acceleration Analysis of Mechanisms (Graphical Methods): Velocity and acceleration analysis of four bar mechanism, slider cranks mechanism. vector polygons.

Velocity Analysis by Instantaneous Center Method Definition, Kennedy's theorem, determination of linear and angular velocity using instantaneous center method for four bar and slider crank mechanism

Flywheels Turning moment diagrams Fluctuation of Energy. Determination of size of flywheels (No problems on punch press and integration method).

- Pedagogy/Course delivery tools: Chalk and talk, Powerpoint presentation, animated videos
- Links: Velocity analysis https://www.youtube.com/watch?v=jzNik6PEKG8
- Links: Flywheel https://www.youtube.com/watch?v=EMazLuxpzxE`
- Laboratory session: Velocity and acceleration analysis of Grashof four bar Mechanism and Slider Crank Mechanism.

Unit III

Cams: types of cams, types of followers, displacement, velocity and acceleration time curves for cam profiles, disc cam with reciprocating follower having knife-edge and roller follower. Follower motions including, SHM, uniform velocity, uniform acceleration and retardation and cycloidal motion.

- Pedagogy/Course delivery tools: Chalk and talk, Powerpoint presentation, animated videos
- Links: Cams and follower https://www.youtube.com/watch?v=u5nwkm5IbqY
- Laboratory session: To understand the effect Cams through simulation.

Unit IV

Static Force Analysis: Introduction, Static equilibrium. Equilibrium of two and three force members. Members with two forces and torque, free body diagrams. Static force analysis of four bar mechanism and slider-crank mechanism (without friction).

- Pedagogy/Course delivery tools: Chalk and talk, PowerPoint presentation, animated videos
- Links: Slider crank mechanism https://www.youtube.com/watch?v=ZO8QEG4x0wY
- Links: Four bar mechanism https://www.youtube.com/watch?v=UwYmWgsjtEQ
- Laboratory session: Static force analysis of Four bar and slider crank mechanism.

Unit V

Governors: Types of governors; force analysis of Porter and Hartnell governors. Controlling force, stability, sensitiveness, Isochronism, effort and power.

Gyroscope: Vectorial representation of angular motion, basic definitions, Gyroscopic couple. Effect of gyroscopic couple on a plane disc, an airplane, a naval ship.

- Pedagogy/Course delivery tools: Chalk and talk, Powerpoint presentation, animated videos
- Links: Governor https://www.youtube.com/watch?v=ASIl3HWTT4U
- Links: Gyroscope https://www.youtube.com/watch?v=ty9QSiVC2g0
- Laboratory session: Porter governor, Hartnell governor, To understand the effect of change of speed in Porter and Hartnell governor through simulation.

Text Books:

1. Theory of Machines: Rattan S.S. Tata McGraw Hill Publishing Company Ltd., New Delhi, 2nd Edition, 2006.
2. Theory of Machines: Sadhu Singh, Pearson Education, 2nd edition, 2007.

Reference Books:

1. Theory of Machines by Thomas Bevan, CBS Publication 1984.
2. Design of Machinery by Robert L. Norton, McGraw Hill, 2001.
3. Mechanisms and Dynamics of Machinery by J. Srinivas, Scitech Publications, Chennai, 2002.
4. Theory of Machines and Mechanisms: Shigley,J.VandUickers, 2nd edition 2005edition.
5. Mechanisms and Dynamics of Machinery: Bansal, 2nd edition 2006
6. Theory of Machines: Khurmi, 4th edition 2004

Course Outcomes (COs):

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

1. Identify different mechanisms and motion (PO1,2,3, PSO1 &2)
2. Determine velocity and acceleration by graphical methods and Develop ability to evaluate the effect of inertial forces in different mechanisms and analyze flywheels. (PO1,2,3, PSO1 &2)
3. Draw cam profile for different types of followers. (PO1,2,3, PSO1 &PSO2)
4. Demonstrate the knowledge of static force analysis of mechanisms. (PO1,2,3, PSO1 &2)
5. Analysis Gyroscopic effect and understand the working of governors. (PO1,2,3, PSO1 &2)

Course Assessment and Evaluation

Continuous Internal Evaluation (CIE) - 50 Marks		
Assessment tool	**Marks**	**Course outcomes addressed**
Internal test-I	30	CO1 &CO2
Internal test-II	30	CO3, CO4 & CO5
Average of the two internal tests will be considered for evaluation of 30 Marks		
Other components- 20 Marks		
Lab experimental work and record writing	15	CO1,CO2,CO3,CO4,CO5
Lab Test	05	CO1,CO2,CO3,CO4,CO5
Semester End Examination (SEE) - 100 Marks		
Semester End Examination	100	CO1, CO2, CO3, CO4 & CO5

FLUID MECHANICS AND MACHINERY	
Course Code: ME53	**Credits: 2:1:0**
Pre – requisites: Nil	**Contact Hours: 30L+30T+30S**
Course Coordinator: Dr. Niranjan Murthy	

Course Content

Unit I

Introduction: Definition and properties, types of fluids, pressure at a point in static fluid, variation of pressure, Pascal's Law, (To be reviewed in class but not for examination) .Pressure- absolute, gauge, vacuum, pressure measurement by manometers, concept of hydrostatic pressure forces. Buoyancy and metacentres, metacentric height. Fluid Kinematics: Types of fluid flow, continuity equation in three dimensions.

- ∉ Pedagogy/Course delivery tools: Chalk and talk, Power point presentation
- ∉ Links: Properties of fluids https://www.youtube.com/watch?v=M6fzIO8DLCQ
- ∉ Links: Buoyancy, Centre of buoyancy https://www.youtube.com/watch?v=-ADgfzbhtuU

Unit II

Fluid Dynamics: Introduction, Euler's equation of motion, Bernoulli's equation – assumptions and limitations. Dimensional Analysis: Derived quantities, dimensions of physical quantities, dimensional homogeneity, Rayleigh method, Buckingham Pi-theorem, dimensionless numbers, similitude, types of similitude.

- ∉ Pedagogy/Course delivery tools: Chalk and talk, Power point presentation
- ∉ Links: Bernoulli's equation https://www.youtube.com/watch?v=9I4o3-vrm98
- ∉ Links: Buckingham Pi-theorem https://www.youtube.com/watch?v=pBkfjNMW26Y

Unit III

Introduction to Turbo machines: Classification of Turbomachines, Introduction to positive displacement machines: comparison with turbomachines. Basic constructional details, Euler's equation for a Turbo machine, Impulse & Reaction machine - Axial flow and radial flow machines, utilization factor, degree of reaction & efficiencies of Turbo machines.

- ∉ Pedagogy/Course delivery tools: Chalk and talk, Power point presentation
- ∉ Links: Basics theory of Turbomachinery https://www.youtube.com/watch?v=473XQrJjDZE
- ∉ Links: Turbomachine classification https://www.youtube.com/watch?v=sdRQYw8sd-U

Unit IV

Hydraulic Turbines: Classification of hydraulic turbines, Various heads and efficiencies, working principle, Velocity triangles, work done, efficiencies etc in Pelton wheel, Francis turbine and Kaplan turbine, characteristic curves. Draft tubes.

- ∉ Pedagogy/Course delivery tools: Chalk and talk, Power point presentation
- ∉ Links: Pelton wheel https://www.youtube.com/watch?v=qbyL--6q7_4
- ∉ Links: Draft tubes https://www.youtube.com/watch?v=YIEdO63BvgQ

Unit V

Centrifugal Pumps: Main Parts of centrifugal pump, Various heads and efficiencies, work done, minimum speed for starting centrifugal pump, Classifications- Performance characteristics of centrifugal pumps, Cavitation in pumps and NPSH. Pumps in series and parallel. Discussion on engineering applications.

- Pedagogy/Course delivery tools: Chalk and talk, Power point presentation
- Links: Centrifugal pumps https://www.youtube.com/watch?v=S3dB-GDpt7M
- Links: Performance characteristics of centrifugal pumps. https://www.youtube.com/watch?v=6Yxc2Q_jBdU

Text Books:

1. Fluid mechanics and Turbo machines by Das, PHI
2. Turbomachines by Dr. Niranjan Murthy and Dr. R.K.Hegde, Sapna Publications .

Reference Books:

1. Principles of Turbo Machinery, D.G.Shepherd, The Macmillan Company.
2. Fundamentals of Turbomachinery: William W Perg John Wiley & Sons, Inc. (2008.)
3. Fluid mechanics by Dr. Niranjan Murthy and Dr. R.K.Hegde, Sapna Publications.

Course Outcomes (COs):

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

1. Able to explain the effects of fluid properties on a flow system. (PO1, 2, 5,11 and PSO1 &2)
2. Able to identify types of fluid flow pattern and describe continuity equation. (PO1, 2, 3, 4, 5,11and PSO1 &2)
3. Apply the Concepts of energy transfer processes in Turbo Machines. (PO1, 2, 3, 4,5,11 and PSO1 &2)
4. Analyze the performance characteristics in hydraulic turbines. (PO1, 2, 3, 4,5,6 and PSO1 &2)
5. Evaluate the performance of centrifugal pumps. (PO1, 2, 3, 4,5,6,10,11 and PSO1 &2)

Course Assessment and Evaluation

Continuous Internal Evaluation (CIE) - 50 Marks		
Assessment tool	**Marks**	**Course outcomes addressed**
Internal test-I	30	CO1 & CO2
Internal test-II	30	CO3, CO4 & CO5
Average of the two internal tests will be considered for evaluation of 30 Marks		
Other components- 20 Marks		
Assignment	10	CO1 & CO2,
Surprise test/Quiz	10	CO3, CO4 & CO5
Semester End Examination (SEM) - 100 Marks		
Semester End Examination	100	CO1, CO2, CO3, CO4 & CO5

MACHINE DESIGN-II	
Course Code: ME54	**Credits: 3:1:0**
Pre – requisites: Nil	**Contact Hours: 45L+30T+45S**
Course Coordinator: Dr. Balasubramanya H S	

Course Content

Unit I

Curved Beams: Stresses in Curved Beams of Standard Cross Sections used in Crane Hook, Punching Presses & Clamps.

Clutches & Brakes: Design of Clutches: Single Plate, Multi Plate, and Cone Clutches. Design of Brakes: Single Block Brake and Simple Band Brake

- Pedagogy/Course delivery tools: Chalk and talk, Power point presentation, animated videos
- Links: Curved Beam https://www.youtube.com/watch?v=bK8NdVYX4HQ
- Links: Clutches & Brakes https://www.youtube.com/watch?v=3T2nxtbVXOE

Unit II

Springs: Types of springs - Stresses in Helical Coil Springs of Circular Cross Sections. Compression Springs, Leaf Springs: Stresses in Leaf Springs & Equalized Stresses.

- Pedagogy/ Course delivery tools: Chalk and talk, Power point presentation, animated videos, Demonstration using IC engine models
- Links: https://www.youtube.com/watch?v=tTBnW5gAieM
- Links: https://www.youtube.com/watch?v=T4IgtIkBnOo

Unit III

Spur Gears: Definitions, Stresses in Gear Tooth: Lewis Equation and Form Factor, Design for Strength, Dynamic Load and Wear Load.

Gear box design- Gear Boxes – types, Gear tooth loads and bearing reactions, Standard speed ratios – speed diagram, Design of multi stage, multi speed gear boxes.

Helical Gears: Definitions, Formative Number of Teeth, Design Based on Strength, Dynamic and Wear Loads.

- Pedagogy/ Course delivery tools: Chalk and talk, Power point presentation, animated videos
- Links: https://www.youtube.com/watch?v=VWkAp4MmuZ8
- Links: https://www.youtube.com/watch?v=-seUIlSWk3A

Unit IV

Bevel Gear: Definitions, Formative Number of Teeth, Design Based on Strength, Dynamic and Wear Loads.

Worm Gears: Definitions, Design Based on Strength, Dynamic, Wear Load and Efficiency of Worm Gear Drives.

- Pedagogy/ Course delivery tools: Chalk and talk, Power point presentation, animated videos
- Links: https://www.youtube.com/watch?v=i9xbJTIGJlE
- Links: https://www.youtube.com/watch?v=q1A-MNfZxQQ

Unit V

Lubrication and Bearings: Lubricants and their properties, Mechanisms of Lubrication, Bearing Modulus, Coefficient of Friction, Minimum Oil Film Thickness, Heat Generated, Heat Dissipated, Bearing Materials, Examples of Journal Bearing, Thrust Bearing Design,

- Pedagogy/ Course delivery tools: Chalk and talk, Power point presentation, animated videos
- Links: https://www.youtube.com/watch?v=MJO7cYJ7VRU
- Links: https://www.youtube.com/watch?v=MJO7cYJ7VRU

Design Data Hand Books:

1. Design Data Hand Book – K. Lingaiah, McGraw Hill, 2nd Ed. 2003.
2. Design Data Hand Book by K. Mahadevan and K. Balaveera Reddy, CBS Publication

Text Books:

1. Mechanical Engineering Design: Joseph E Shigley and Charles R. Mischke. McGraw Hill International edition, 6th Edition 2003.
2. Design of Machine Elements: V.B. Bhandari, Tata McGraw Hill Publishing Company Ltd., New Delhi, 2nd Edition 2007.

Reference Books:

1. Machine Design: Robert L. Norton, Pearson Education Asia, 2001. 2.
2. Design of Machine Elements: M.F. Spotts, T.E. Shoup, L.E. Hornberger, S.R. Jayram and C.V. Venkatesh, Pearson Education, 2006. 3.
3. Machine Design: Hall, Holowenko, Laughlin (Schaum's Outlines series) Adapted by S.K. Somani, Tata McGraw Hill Publishing Company Ltd., New Delhi, Special Indian Edition, 2008. 4.
4. Machine Design: A CAD Approach: Andrew D DIMAROGONAS, John Wiley Sons, Inc, 2001.

Course Outcomes (COs):

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

1. Evaluate and analyse stresses in curved beams and to apply the design concepts for clutches and brakes. (PO1, 2, 3, 4, PSO2)
2. Design and develop various types of springs for various applications. (PO1, 2, 3, 4, PSO1 &2)
3. Decide and design the spur gear, single speed and multi speed gear box and helical gears for engineering applications. (PO1, 2, 3, 4, PSO 2)
4. Understand and choose the design concepts for the bevel and worm gear. (PO1, 2, 3, 4, PSO1 &2)
5. Identify & choose lubricants, bearings for various applications. (PO1, 2, 3, 4, PSO2)

Course Assessment and Evaluation:

Continuous Internal Evaluation (CIE) - 50 Marks		
Assessment tool	**Marks**	**Course outcomes addressed**
Internal test-I	30	CO1 &CO2
Internal test-II	30	CO3, CO4 & CO5
Average of the two internal tests will be considered for evaluation of 30 Marks		
Other components- 20 Marks		
Assignment	10	CO1, CO2, CO3
Quiz	10	CO4 & CO5
Semester End Examination (SEE) - 100 Marks		
Semester End Examination	100	CO1, CO2, CO3, CO4 & CO5

TURBO MACHINERY LABORATORY	
Course Code: MEL56	**Credits: 0:0:1**
Pre – requisites: Nil	**Contact Hours: 30P**
Course Coordinator: Mrs. Bijayalakshmi Das	

PART - A

Conduct the following experiments

1. Determination of coefficient of friction of flow in a pipe.
2. Determination of minor losses in flow through pipes.
3. Determination of force developed by the impact of jets on vanes.
4. Calibration of flow measuring devices
    a. Orifice plate
    b. Venturimeter
    c. V-Notch
    d. Rectangular Notch

PART - B

Conduct the following experiments

1. Performance testing of turbines:
    a. Pelton wheel
    b. Francis turbine
    c. Kaplan turbine
2. Performance testing of pumps:
    a. Single-stage centrifugal pump
    b. Multistage centrifugal pump
3. Reciprocating Pump

Text Books:

1. **An Introduction to energy conversion**, Volume III – Turbo Machinery, V.Kadambi and Manohar Prasad, New Age International Publishers (P) Ltd.
2. Manufacturing Process – II laboratory manual, Department of Mechanical Engineering, RIT.
3. **A Treatise on Turbo Machines",** G. Gopalakrishnan, & D. Prithviraj, Scitech Publications (India) Pvt. Limited 2nd edition 2002

Reference Books:

1. **Principles of Turbo Machinery",** D.G.Shepherd, The Macmillan Company (1964)
2. **Fundamentals of Turbomachinery**: William W Perg John Wiley & Sons, Inc. (2008.)

Web Links And Video Lectures:

1. https://www.youtube.com/watch?v=f83D4h2LN4I
2. https://www.youtube.com/watch?v=xXsqpjBs4Lc
3. https://www.youtube.com/watch?v=3BG7E_h479o
4. https://www.youtube.com/watch?v=-pdM5xdU84M

5. https://www.youtube.com/watch?v=oND8ZwLpP14
6. https://www.youtube.com/watch?v=r29fl7_Ku8k
7. https://www.youtube.com/watch?v=NgVSF7X57xc
8. https://www.youtube.com/watch?v=qPM3EpGT1QY
9. https://www.youtube.com/watch?v=KUnEGPRxCb4
10. https://www.youtube.com/watch?v=gt0d4tZVrDs
11. https://www.youtube.com/watch?v=oCHDKD9Rzd8
12. https://www.youtube.com/watch?v=B8aq_W1JI6o

Course Outcomes (CO):

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

1. Conduct experiments involving pipe friction, minor losses, impact of jets and calibration of flow measuring devices, (PO1,2,4,5,11, PSO 1 ,2)
2. Perform performance of testing of hydraulic turbines (Pelton wheel, Francis turbine and Kaplan turbine) and evaluate their operating characteristics and efficiencies under different loading conditions. (PO1,2,3,4,5,6,11, PSO 1,2)
3. Conduct performance tests on centrifugal and reciprocating pumps and analyze their operating characteristics, efficiencies and hydraulic performance parameters. (PO1,2,3,4, 5,6,10, 11,PSO1,2)

Course Assessment and Evaluation

Continuous Internal Evaluation (CIE): 50 Marks		
Assessment Tool	**Marks**	**Course Outcomes addressed**
Weekly evaluation of laboratory journals/ reports after the conduction of every experiment	30	CO1,CO2 & CO3
Practical Test	20	CO1,CO2 & CO3
Semester End Examination (SEE)	50	CO1,CO2 & CO3

DESIGN & DYNAMICS LABORATORY	
Course Code: MEL57	**Credits: 0:0:1**
Pre – requisites: Design of Machine Elements	**Contact Hours: 30P**
Course Coordinator: Dr. Balasubramanya H S	

PART A

Conduct the following experiments

1. Longitudinal vibration of spring mass system.
2. Transverse vibration of a beam.
3. Longitudinal vibration of spring mass system loaded through beam.
4. Single rotor system subjected to torsional vibration.
5. Two rotor systems subjected to torsional vibration.
6. Porter governor.
7. Hartnell governor.

PART B

Conduct the following experiments

1. Whirling of shafts with pulley and without pulley.
2. Determination of principal stresses and strains in a member subjected to combined loading strain rossets.
3. Determination of fringe constant of photo elastic material using circular disc.
4. Determination of fringe constant of photo elastic material using pure bending specimen.
5. Determination of stress concentration using photo elasticity.
6. Pressure distribution in journal bearing.
7. Calibration and characterization of state of the material using computerized photo-elasticity set up.
8. Strain measurement using rectangular specimen in computerized photo-elasticity setup.
9. Gyroscope – Demo
10. FFT analyzer – Demo

Text Books:

1. "Theory of Machines", Sadhu Singh, Pearson Educ ation, 2nd Edition, 2007.
2. "Mechanical Vibrations", G.K. Grover, Nem Chand and Bros, 6th Edition, 1996

Reference Books:

1. "Shigley's Mechanical Engineering Design", Rich ards G. Budynas and J. Keith Nisbett, McGraw-Hill Education, 10th Edition, 2015.
2. "Design of Machine Elements", V.B. Bhandari, TM H publishing company Ltd. New Delhi, 2nd Edition

Web Links And Video Lectures:

1. https://www.youtube.com/watch?v=VQ1BASCaKGQ&list=PLjDYfLM5SrdhDhnVJ7Oa0i28-cH6LyvcQhttps://www.youtube.com/watch?v=xXsqpjBs4Lc
2. https://www.youtube.com/watch?v=16twhcVfjUU&pp=ygUjZGVzaWduK2FuZCtkeW5hbWljcytsYWIrZXhwZXJpbWVudHM%3D

3. https://www.youtube.com/watch?v=XSHyBejnN90&pp=ygUjZGVzaWduK2FuZCtkeW5hbWljcytsYWIrZXhwZXJpbWVudHM%3D
4. https://www.youtube.com/watch?v=N_StSKc_Vzk&pp=ygUjZGVzaWduK2FuZCtkeW5hbWljcytsYWIrZXhwZXJpbWVudHM%3D
5. https://www.youtube.com/watch?v=puEBECEhhiQ&pp=ygUjZGVzaWduK2FuZCtkeW5hbWljcytsYWIrZXhwZXJpbWVudHM%3D

Course Outcomes (CO):

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

1. Apply the principles of dynamics &Mechanical vibrations, design& conduct experiments related to Longitudinal, transverse, torsional vibrations, Governors, bearings and lubrication. (PO 1, 2, 3, 4, 9, PSO 1, 2)
2. Demonstrate the use of experimental techniques and design the machine elements using Polarioscope and strain gauges. (PO 1, 2, 3, 4, 9, PSO 1, 2)
3. The above skills with practical experiments will equip students to realize efficient & better design of machine elements in practice. (PO 1, 2, 3, 4, 9, PSO 1, 2)

Course Assessment and Evaluation

Continuous Internal Evaluation (CIE): 50 Marks		
Assessment Tool	**Marks**	**Course Outcomes addressed**
Weekly evaluation of laboratory journals/ reports after the conduction of every experiment	30	CO1, CO2 & CO3
Practical Test	20	CO1, CO2 & CO3
Semester End Examination (CEE)	50	CO1, CO2 & CO3

RESEARCH METHODOLOGY AND INTELLECTUAL PROPERTY RIGHTS	
Course Code: AL58	**Credits: 3:0:0**
Pre – requisites: Nil	**Contact Hours: 45L+45S**
Course Coordinator: Dr. Sagar	

Course Content

Unit I

Research Methodology

Introduction: Meaning of Research, Objectives of Research, Types of Research, Ethics in Research, Types of Research Misconduct.

Literature Review and Technical Reading, New and Existing Knowledge, Analysis and Synthesis of Prior Art, Bibliographic Databases, Conceptualizing Research, Critical and Creative Reading.

Citations: Functions and Attributes, Impact of Title and Keywords on Citations, Knowledge flow through Citations, Acknowledgments, and Attributions.

- Pedagogy / Course delivery tools: Chalk and talk, PowerPoint presentation.
- Links: https://onlinecourses.nptel.ac.in/noc22_ge08/preview

Unit II

Research Design: Need for Research Design, Important Concepts Related to Research Design: Dependent and Independent Variables, Extraneous Variable, Variable, Common Control, Confounded Relationship, Research Hypothesis, Experimental and Control Groups, Treatments.

Experimental Designs: Introduction to Randomised Block Design, Complete Randomised Design, Latin Square Design, and Factorial Design.

- Pedagogy / Course delivery tools: Chalk and talk, PowerPoint presentation.
- Links: https://onlinecourses.nptel.ac.in/noc22_ge08/preview

Unit III

Method of Data Collection: Primary and Secondary Data Collection.

Sampling Design: Sampling fundamentals, Measurement, and Scaling Techniques, Criteria of Selecting a Sampling Procedure, Characteristics of a Good Sample Design, and Types of Sample Design.

Data Analysis: Testing of Hypotheses: Null Hypothesis, Alternative Hypothesis, Type I and Type II Errors, Level of Significance. Procedure for Hypothesis Testing: Mean, Variance, Proportions. Chi-square Test, Analysis of Variance (One Way ANOVA), and Covariance (ANOCOVA)

- Pedagogy / Course delivery tools: Chalk and talk, PowerPoint presentation.
- Links: https://onlinecourses.nptel.ac.in/noc23_ge36/preview

Unit IV

Intellectual Property Rights

Introduction to IPR: Different forms of IPR, Role of IPR in Research and Development. TRIPS Agreement, Patent Cooperation Treaty (PCT).

Patents: Brief history of Patents-Indian and Global Scenario, Principles Underlying Patent Law, Types of Patent Applications in India, Procedure for Obtaining a Patent. Non Patentable Inventions. Rights Conferred to a Patentee, Basmati Rice Patent Case.

- ∉ Pedagogy / Course delivery tools: Chalk and talk, PowerPoint presentation.
- ∉ Links: https://archive.nptel.ac.in/courses/110/105/110105139/

Unit V

Design: What is a Design? Essential Requirements for a Registrable Design, Procedure of Registration of a Design,

Trademarks: Essentials of a Trademark, Registration, and Protection of Trademarks, Rights Conferred by Registration of Trademarks, Infringements, Types of Reliefs, Case Studies.

Copyrights: Characteristics of Copyrights, Rights Conferred by Registration of Copyrights, Registration of Copyrights, Infringements, Remedies against Infringement of Copyrights, Case studies

- ∉ Pedagogy / Course delivery tools: Chalk and talk, PowerPoint presentation.
- ∉ Links: https://archive.nptel.ac.in/courses/110/105/110105139/

Text Books:

1. C. R Kothari, Gourav Garg, Research Methodology – Methods and Techniques. New Age International Publishers.
2. Dr. B L Wadehra – Law relating to Intellectual property. Universal Law Publishing Co.
3. Dipankar Deb, Rajeeb Dey, Valentina E. Balas "Engineering Research Methodology", ISSN 1868-4394 ISSN 1868-4408 (electronic), Intelligent Systems Reference Library, ISBN 978-981-13-2946-3 ISBN 978-981-13-2947-0 (eBook), https://doi.org/10.1007/978-981-13-2947-0.

Reference Books:

1. David V. Thiel "Research Methods for Engineers" Cambridge University Press, 978-1-107-03488-4

Course Outcomes (COs):

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

1. Possess the knowledge of research and conduct a literature review**.** (PO8,10)
2. Apply the knowledge of research design and design of experiments. (PO4, 8, 10)
3. Analyse data collection methods, analysis, and sampling design. (PO4,8,10)
4. Understand the global and Indian scenarios of patents and patent applications. (PO8, 10)
5. Acquire the requirements of registration and infringements related to trademarks, copyrights, and designs. (PO8, 10)

Course Assessment and Evaluation:

Continuous Internal Evaluation (CIE): 50 Marks		
Assessment tool	**Marks**	**Course outcome attained**
Internal test - 1	30	CO1, CO2, CO3
Internal test - 2	30	CO4, CO5
The average of the two internal tests will be taken for 30 marks		
Other Components		
Assignment	10	CO1, CO2
Quiz	10	CO3, CO4, CO5
Semester End Examination (SEE)	100	CO1, CO2, CO3, CO4, CO5

MECHATRONICS & MEMS	
Course Code: MEE551	**Credits: 3:0:0**
Pre – requisites: Nil	**Contact Hours: 45L+45S**
Course Coordinator: Dr. R. Kumar	

Course Content

Unit I

Mechatronics, Sensors and Transducers: Introduction to Mechatronics Systems, Measurement Systems Control Systems Microprocessor based Controllers. Sensors and Transducers – Performance Terminology – Sensors for Displacement, Position and Proximity; Velocity, Motion, Force, Fluid Pressure, Liquid Flow, Liquid Level, Temperature, Light Sensors Selection of Sensors.

- Pedagogy/Course delivery tools: Chalk and talk, Power point presentation, animated videos
- Lab component/ Practical topics: Arc Welding and soldering
- Links: Mechatronics, sensor https://www.youtube.com/watch?v=-qdiHCmWi1U
- Links: Transducers https://www.youtube.com/watch?v=nSeW3R2hr1A

Unit II

Signal Conditioning Introduction to signal conditioning. The operational amplifier, Protection, Filtering, wheat stone bridge, digital signals Multiplexers, data acquisition, Introduction to Digital system processing pulse modulation.

- Pedagogy/ Course delivery tools: Chalk and talk, Power point presentation, animated videos, Demonstration using IC engine models
- Links: Signal conditioning https://rb.gy/yuqp3
  https://rb.gy/n3dg2

Unit III

Actuation Systems Electrical Actuation Systems – Mechanical Switches – Solid State Switches, Solenoid Construction and working principle of DC and AC Motors Stepper Motors-switching circuitries for stepper motor – AC & DC Servo motors. Introduction to Hydraulic and Pneumatic actuation systems and their application.

- Pedagogy/ Course delivery tools: Chalk and talk, Power point presentation, animated videos
- Links: stepper motor https://www.youtube.com/watch?v=f0vrTNmCTkc
- Links: servo motor https://www.youtube.com/watch?v=ditS0a28Sko

Unit IV

Micro Electro Mechanical Systems (Mems) Introduction –MEMS, MEMS micro sensor, Mems micro actuator, manufacturing processes of MEMS, commonly used MEMS micro sensors, Advantages and applications of MEMS.

- Pedagogy/ Course delivery tools: Chalk and talk, Power point presentation, animated videos
- Links: MEMS sensor https://www.youtube.com/watch?v=eqZgxR6eRjo
- Links:MEMS- Manufacturing https://rb.gy/uht0k

Unit V

Programmable Logic Controllers Programmable Logic Controllers– Basic Structure – Input / Output Processing – Programming –Mnemonics – Timers, Internal relays and counters – Shift Registers- Master and Jump Controls – Data Handling – Analogs Input / Output – Selection of a PLC.

- Pedagogy/ Course delivery tools: Chalk and talk, Power point presentation, animated videos
- Links: PLC https://www.youtube.com/watch?v=ReTtgzN-Dmc
- Links: PLC programming https://www.youtube.com/watch?v=Qf32qtHfowQ

Text Books:

1. Mechatronics- W. Bolton, Longman, 2nd Pearson Publications, 2007
2. Microprocessor Architecture, programming and applications with 8085.8085A- R.S. Ganokar, Wiley Eastern.

Reference Books:

1. Mechatronics Principles & applications by Godfrey C. Canwerbolu, Butterworth-Heinemann 2006.
2. Mechatronics- DanNecsulescu, Pearson Publication, 2007
3. Introduction Mechatronics & Measurement systems, David. G. Aliciatore & Michael.B. Bihistand, tata McGraw Hill, 2000.
4. Mechatronics : Sabricentinkunt, John wiley& sons Inc. 2007

Web links and video lectures (e-Resources)

- https://www.youtube.com/watch?v=f0vrTNmCTkc
- https://www.youtube.com/watch?v=eqZgxR6eRjo
- https://www.youtube.com/watch?v=ReTtgzN-Dmc • https://www.youtube.com/watch?v=Qf32qtHfowQ
- https://onlinecourses.nptel.ac.in/noc21_me27/preview

Course Outcomes (COs):

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

1. Define Mechatronics systems and recognize its various elements. (PO 1, 2, 5,11, PSO 1 & 2)
2. Compile the key signal conditioning circuits. (PO 1, 2, 4 ,5,11, PSO 1 & 2)
3. Express the concepts of actuation systems (PO 1, 2, 3, 5, 11, PSO 1 & 2)
4. Understand the concepts of MEMS. (PO 1, 2, 3, 4, 5,9,10,11, PSO 1 & 2)
5. Express the concepts of programming logic controllers. (PO 1, 2, 3, 4, 5,11, PSO 1 & 2)

Continuous Internal Evaluation (CIE): 50 Marks		
Assessment tool	**Marks**	**Course outcomes addressed**
Internal test-I	30	CO1 & CO2
Internal test-II	30	CO3, CO4 & CO5
Average of the two internal tests will be considered for evaluation of 30 Marks		
Other components- 20 Marks		
Assignment	10	CO1, CO2, CO3
Quiz	10	CO4 & CO5
Semester End Examination (SEE): 100 Marks		
Semester End Examination	100	CO1, CO2, CO3, CO4 & CO5

HYDRAULICS AND PNEUMATICS	
Course Code: MEE552	**Credits: 3:0:0**
Pre – requisites: Nil	**Contact Hours: 45L+45S**
Course Coordinator: Dr. Mohandas K N	

Course Content

Unit I

Introduction to Hydraulic Power: Pascal's law and problems on Pascal's Law, continuity Equations, introduction to conversion of Units, Structure of Hydraulic Control System. The Source of Hydraulic Power: Pumps Pumping theory, pump classification, gear pumps, vane pumps, piston pumps, pump performance, pump selection. Variable displacement pumps.

Hydraulic Actuators: Linear Hydraulic Actuators [cylinders], Mechanics of Hydraulic Cylinder Loading.

- Pedagogy/Course delivery tools: Chalk and talk, Power point presentation
- Links: Introduction to Hydraulic Power https://www.youtube.com/watch?v=8xd7cWvMrvE
- Links: Hydraulic Actuators https://www.youtube.com/watch?v=akZjDHD6JC4&t=3s

Unit II

Hydraulic Motors: Hydraulic Rotary Actuators, Gear motors, vane motors, piston motors, Hydraulic motor theoretical torque, power and flow rate, hydraulic motor performance.

Control Components in Hydraulic Systems: Directional Control Valves –Symbolic Representation, Constructional features, pressure control valves –direct and pilot operated types, Flow control valves.

- Pedagogy/Course delivery tools: Chalk and talk, Power point presentation
- Links: Hydraulic Motors https://www.youtube.com/watch?v=dPD8YuojtN0&t=29s
- Links: Control Components https://www.youtube.com/watch?v=O97nymNUY-8

Unit III

Hydraulic Circuit Design and Analysis: Control of single and double –acting Hydraulic Cylinder, regenerative circuit, pump unloading circuit, Counter Balance Valve application, Hydraulic cylinder sequencing circuits. Cylinder synchronizing circuits, speed control of hydraulic cylinder, Speed control of hydraulic motors, Accumulators.

- Pedagogy/Course delivery tools: Chalk and talk, Power point presentation
- Links: Circuit Design https://www.youtube.com/watch?v=CYeA4CTszNE
- Links: Cylinder synchronizing circuits https://www.youtube.com/watch?v=DeiMl8IgPW4&t=113s

Unit IV

Introduction to Pneumatic Control: Choice of working medium, characteristics of compressed air. Structure of Pneumatic control system. Compressed air: Production of compressed air – compressors, preparation of compressed air- Driers, Filters, Regulators, Lubricators, Distribution of compressed air.

Pneumatic Actuators: Linear cylinders –Types, conventional type of cylinder working, end Position cushioning, seals, mounting arrangements applications.

- ∉ Pedagogy/Course delivery tools: Chalk and talk, Power point presentation
- ∉ Links: Pneumatic Control https://www.youtube.com/watch?v=NRaG_McFSuI
- ∉ Links: Pneumatic Actuators https://www.youtube.com/watch?v=vF61cZerj2M

Unit V

Directional Control Valves: Symbolic representation as per ISO 1219 and ISO 5599. Simple Pneumatic Control: Direct and indirect actuation pneumatic cylinders, Basic pneumatic valves, Flow control valves and speed control of cylinders supply air throttling and exhaust air throttling, use of quick exhaust valve. Pressure dependent controls types. Time dependent controls.

Maintenance of Hydraulic Systems: Hydraulic oils; Desirable properties, general type of fluids, sealing devices, reservoir system, filters and strainers, problem caused by gases in hydraulic fluids, wear of moving parts due to solid particle contamination, temperature control, trouble shooting.

- ∉ Pedagogy/Course delivery tools: Chalk and talk, Power point presentation
- ∉ Links: Directional Control Valves https://www.youtube.com/watch?v=bXXL-0sf8gs
- ∉ Links: Maintenance of Hydraulic Systems https://www.youtube.com/watch?v=j6UIbb5XwXQ

Text Books:

1. **Fluid Power with applications,** Anthony Esposito, Fifth edition Pearson education, Inc. 2017.
2. **Pneumatics and Hydraulics,** Andrew Parr. Jaico Publishing Co. 2017.

Reference Books:

1. **Oil Hydraulic Systems - Principles and Maintenance,** S.R. Majumdar, Tata Mc Graw Hill Publishing company Ltd. 2001.
2. **Pneumatic Systems,** S.R. Majumdar, Tata Mc Graw Hill publishing Co., 1995.
3. **Industrial Hydraulics,** Pippenger, Hicks, McGraw Hill, New York, 2009

Course Outcomes (COs):

Students will be able to:

1. **Demonstrate** the working of hydraulic and pneumatic systems. (PO1, 2, 5, 11, PSO1 &2)
2. **Identify** the controlling components of hydraulic and pneumatic systems. (PO1, 2, 3, 5,11, PSO1&2)
3. **Design** the hydraulic and pneumatic systems for various applications. (PO1, 2, 3,5,10,11, PSO1 &2)
4. **Examine** the choice, preparation and distribution of compressed air. (PO1, 2, 3, 11, PSO1 & 2)
5. **Predict** the use of pressure and time dependent controls. (PO1, 2, 3, 5,11, PSO1&2)

Course Assessment and Evaluation:

Continuous Internal Evaluation (CIE): 50 Marks		
Assessment tool	**Marks**	**Course outcomes addressed**
Internal test-I	30	CO1 & CO2
Internal test-II	30	CO3, CO4 & CO5
Average of the two internal tests will be considered for evaluation of 30 Marks		
Other components- 20 Marks		
Assignment	10	CO1,CO2, CO3
Quiz	10	CO4 & CO5
Semester End Examination (SEE): 100 Marks		
Semester End Examination	100	CO1, CO2, CO3, CO4 & CO5

COMPOSITE MATERIALS	
Course Code: MEE553	**Credits: 3:0:0**
Pre – requisites: Nil	**Contact Hours: 45L+45S**
Course Coordinator: Dr. Prakrathi S	

Course Content

Unit I

Introduction: Introduction to Composite Materials: Fundamentals of composites – need for composites, Definition, classification and characteristics of composite Materials – fibrous composites, laminated composites and particulate composites. Advantages, Disadvantages of Composite materials.

- Pedagogy/Course delivery tools: Chalk and talk, Power point presentation
- Links: Introduction to Composite Materials introduction https://www.youtube.com/watch?v=0kB0G6WKhKE&t=4s
- Links: Classification of composites https://www.youtube.com/watch?v=YWdrhMk2jjM&t=1059s

Unit II

Processing of Composites Commonly used Matrices, Basic Requirements in Selection of constituents, Spray processes - Osprey Process, Pultrusion, Filament winding, Hand lay-up techniques, vacuum Bag moulding, Pulforming, Thermoforming, Compression Moulding – Injection Moulding – Resin Transfer Moulding.

- Pedagogy/Course delivery tools: Chalk and talk, Power point presentation
- Links: Processing of composites https://youtu.be/yxrRfKD-y5E
- https://youtu.be/ZZRg0kmNN7k

Unit III

Micro Mechanical Analysis of a Lamina: Introduction, Volume and Mass Fractions, Density, and Void Content, Numerical problems, Assumption and limitations of micromechanical analysis, Mechanical properties.

- Pedagogy/Course delivery tools: Chalk and talk, Power point presentation
- Links https://www.youtube.com/watch?v=lH4JTf9-U5A
- https://www.youtube.com/watch?v=WhcBM568TlM

Unit IV

Macro Mechanics of a Lamina: Introduction, Hookes law for different types of materials, Hooke's law for two-dimensional angle lamina, engineering constants - Numerical problems.
Micromechanical Analysis of Laminates- laminate codes, Classical lamination theory, and stress and strain in laminate.

- Pedagogy/Course delivery tools: Chalk and talk, Power point presentation
- Links https://www.youtube.com/watch?v=sH1dPdevhrw
- https://www.youtube.com/watch?v=YMeWulfHLXE
- https://www.youtube.com/watch?v=xf6TWED-I3c

Unit V

Non-conventional composites Nano composites, Polymer clay nano composites, self-healing composites, Self-reinforced composites, bio composites, hybrid composites.

Applications: Automobile, Aircrafts. Missiles. Space hardware, Electrical and electronics, Marine, recreational and sports equipment, future potential of composites.

- Pedagogy/Course delivery tools: Chalk and talk, Power point presentation
- Links https://www.youtube.com/watch?v=CohtRdEdGt8
- https://www.youtube.com/watch?v=OVnrl_hBfc0
- https://www.youtube.com/watch?v=Ufb0GpLCaVI

Text Books:

1. Autar K Kaw, "Mechanics of composite Materials" Second Edition, Taylor and Francis,ISBN 978-0-8493-1343-1.
2. Krishnan K Chawla, "Composite material science and Engineering", Springer, ISBN 978-0-387-74364-6.

Reference Books:

1. D Hull and T. W. Clyne, "An introduction to composite materials", Cambridge University Press, ISBN- 9781139170130.
2. Rober M. Jones "Mechanics of composite Materials" Second Edition, CRC Press, ISBN 9781315272986

Course Outcomes (COs):

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

1. Discuss the need for composite materials by comparing the limitations of conventional materials. (PO1, 2, 6, 11, PSO1, PSO2).
2. Summarize the knowledge of different fabrication techniques of composite materials. (PO1, 2,3,4, 5, 11, PSO1 ,2).
3. Evaluate the volume and weight fractions, elastic properties of the lamina. (PO1, 2,3,4, 5, 11, PSO1,2).
4. Predict the responses of the composite on the basis of properties and geometries of the individual phases. (PO1, 2, 5, 11, PSO1, PSO2).
5. Examine different unconventional composite materials and the applications of composite materials in various Engineering fields. (PO1, 2,3,4,5,6, 7, 11, PSO1, PSO2).

Course Assessment and Evaluation:

Continuous Internal Evaluation (CIE): 50 Marks		
Assessment tool	**Marks**	**Course outcomes addressed**
Internal test-I	30	CO1 & CO2
Internal test-II	30	CO3, CO4 & CO5
Average of the two internal tests will be considered for evaluation of 30 Marks		
Other components- 20 Marks		
Assignment	10	CO3,CO4, CO5
Quiz/ Presentations	10	CO1, CO2 & CO5
Semester End Examination (SEE): 100 Marks		
Semester End Examination	100	CO1, CO2, CO3, CO4 & CO5

ADDITIVE MANUFACTURING	
Course Code: MEE554	**Credits: 3:0:0**
Pre – requisites: Nil	**Contact Hours: 45L+45S**
Course Coordinator: Dr. Jayachristiyan K G	

Course Content

Unit I

Additive Manufacturing: Introduction to Additive Manufacturing AM evolution, The Generic AM Process, AM – An Integral part of Time compression Engineering, Distinction between AM & CNC machining, Steps in AM, Classification of AM processes, Advantages of AM and Types of materials for AM. Vat Photopolymerization AM Processes (SLA) Principle of operation, applications, Solid Ground Curing: Principle of operation, applications. Material Jetting AM Processes: Principle of operation, applications, Binder Jetting AM Processes Principle of operation, applications

- Pedagogy/Course delivery tools: Chalk and talk, Powerpoint presentation
- Links: **Introduction to AM** https://www.youtube.com/watch?v=ICjQ0UzE2Ao
- Links: **Vat Photo polymerization** https://www.youtube.com/watch?v=7jNodHYUQc8

Unit II

Extrusion-Based Systems: Introduction, Basic Principles, Fused Deposition Modeling, Materials, Limitations of FDM. Sheet Lamination AM Processes: Principle of operation, applications Powder Bed Fusion AM Processes Selective Laser Sintering and SLM: Type of machine principle of operation, process parameters, application. Sheet Lamination AM Processes: Bonding Mechanisms, Ultrasonic Consolidation (UC), Gluing, Thermal bonding.

- Pedagogy/Course delivery tools: Chalk and talk, Power point presentation
- Links: Solid Ground curing https://www.youtube.com/watch?v=ThwFB12cbnM

Unit III

Directed Energy Deposition AM Processes: Process Description, Material Delivery, Laser Engineered Net Shaping (LENS), Direct Metal Deposition (DMD), Electron Beam Based Metal Deposition, Processing-structure-properties, relationships, Benefits and drawbacks, Applications of Directed Energy Deposition Processes Materials science for AM - Multifunctional and graded materials in AM, Role of solidification rate, Evolution of non-equilibrium structure, microstructural studies, Structure property relationship. Introduction to Design for Additive Manufacturing (DfAM): Need for Design for Additive Manufacturing (DfAM), CAD tools vs. DfAM tools, Requirements of DfAM methods, General Guidelines for DfAM Topology Optimization Lattice Structures, Overhangs and Support Material.

- Pedagogy/Course delivery tools: Chalk and talk, Powerpoint presentation
- Links: **Design for Additive Manufacturing** https://www.youtube.com/watch?v=U0xxd70g0y0
- Links: **Post-processing** https://www.youtube.com/watch?v=uuCt_8nGDrM

Unit IV

Wire Arc Additive Manufacturing: Types of WAAM process, Gas Tungsten Arc, Gas Metal Arc , Plasma Arc Cold Metal Transfer Process, parameters, applications, advantages and disadvantages, Metrological aspects of WAAM process, Friction stir additive manufacturing: process, parameters, advantages, limitations and applications, Additive friction stir deposition process: principle, parameters, applications, functionally graded additive manufacturing components.

- Pedagogy/Course delivery tools: Chalk and talk, Powerpoint presentation
- Links: **Directed Energy Deposition Processes** https://youtu.be/LjWL-lQe6ok

Unit V

Software Issues for Additive Manufacturing: Preparation of CAD Models – the STL File, Problems with STL Files, STL File Manipulation, Beyond the STL File, Additional Software to Assist AM. Post Processing of AM Parts: Support Material Removal, Surface Texture Improvement, Accuracy Improvement, Aesthetic Improvement, Preparation for use as a Pattern, Property Enhancements using Non-thermal and Thermal Techniques, Guidelines for Process Selection: Introduction, Selection Methods for a Part, Challenges of Selection, Example System for Preliminary Selection, Process Planning and Control.

- Links: Pedagogy/Course delivery tools: Chalk and talk, Powerpoint presentation
- **Direct Methods for Rapid Tool** https://youtu.be/RQVjwSG1-XY

Text Books:

1. Additive Manufacturing Technologies, I. Gibson l D. W. Rosen l B. Stucker, Springer New York Heidelberg Dordrecht London, 2010.
2. Stereo lithography and other RP & M Technologies, Paul F.Jacobs: "SME, NY 1996.
3. Rapid manufacturing, Fiham D.T & Dinjoy S.S Verlog London 2001.
4. Rapid Prototyping: Principles and Application, by Rafiq I. Noorani

Course Outcomes (COs):

1. Identify the stages of development related to RP system and classification based of material types [PO1,PO2, PO4, PSO1,PSO2]
2. Compare different RP process based on process parameter [PO1,PO2,PO4, PSO1,PSO2]
3. Analyze the different Rapid Tooling process for batch production [PO1,PO2,PO3, PO4,PO5,PSO1,PSO2]
4. Select and use correct data formats in the manufacture of a 3D printed part [PO1,PO2,PO3,PO4,PO5, PSO1,PSO2]
5. Analyze suitable orientation workflow for better part fabrication process & reduced part build errors [P01,PO2,PO3, PO4, PO5,PSO1,PSO2]

Course Assessment and Evaluation:

Continuous Internal Evaluation (CIE): 50 Marks		
Assessment tool	**Marks**	**Course outcomes addressed**
Internal test-I	30	CO1,CO2 & CO3
Internal test-II	30	CO3, CO4 & CO5
Average of the two internal tests will be considered for evaluation of 30 Marks		
Other components- 20 Marks		
Assignment	10	CO1, CO2,CO3,CO4, CO5
Quiz/ Project	10	CO1, CO2,CO3,CO4, CO5
Semester End Examination (SEE): 100 Marks		
Semester End Examination	100	CO1, CO2, CO3, CO4 & CO5

ELECTRIC VEHICLE TECHNOLOGY	
Course Code: MEE555	**Credits: 3:0:0**
Pre – requisites: Nil	**Contact Hours: 45L+45S**
Course Coordinator: Mr. Gururaj Lalagi	

Course Content

Unit I

Review of conventional IC engine vehicle –limitations and environmental impact, Introduction to Electric vehicles: brief study of hybrid vehicles, architecture of hybrid electric vehicles, Need for electric vehicles, Introduction to EV design- basic working principle of plug-in EV, Importance /advantages of EV and hybrid vehicles in present context.

- Pedagogy/Course delivery tools: Chalk and talk, Power point presentation, animated videos
- Lab component/ Practical topics: IC engine Basics and EV basics -IC engine lab
- Links: Electric Car Works https://www.youtube.com/watch?v=tJfERzrG-D8
- Links: EV Electrical Systems BASICS https://www.youtube.com/watch?v=mNOYS-duUJY

Unit II

Electric vehicle power train: Brief outline of electric motor**,** battery pack, inverter, charger and converter, series hybrid electric drive train, parallel hybrid electric drive train, operation modes- pure electric traction mode, pure engine traction mode, hybrid traction mode, engine traction with battery charging mode, regenerative braking mode, battery charging mode. Vibration and Noise reduction

- Pedagogy/ Course delivery tools: Chalk and talk, Power point presentation, animated videos, Demonstration using IC engine models
- Lab component/ Practical topics: Battery, Motor (Project lab)
- Links: Hybrid electric vehicles https://www.youtube.com/watch?v=h5ysddrlXLw&t=400s
- Links: Electric Vehicle https://www.youtube.com/watch?v=xE0d0JtXVLw

Unit III

Batteries- Types of batteries, architecture, battery charging and discharging cycles, use of batteries in powertrain, battery modeling and**,** Battery state evaluation: State of charge (SOC), State of health (SOH), State of Life (SOL), Battery Management System (BMS**)**, Challenges encountered in BMS and the possible solutions

- Pedagogy/ Course delivery tools: Chalk and talk, Power point presentation, animated videos
- Lab component/ Practical topics: Li-ion Battery (Project Lab)
- Links: Batteries https://www.youtube.com/watch?v=nrxmQhbZUTc
- Links: BMS https://www.youtube.com/watch?v=q4wDa_m9-8E

Unit IV

Electric Motors and Converters- AC/DC Motors/ Generators, Brushed DC Motor/ Brushless DC Motor -Torque Characteristics, motor layout, switched reluctance motors, induction motors, Actuators & Capacitors., DC-AC & AC-DC Convertors

- Pedagogy/ Course delivery tools: Chalk and talk, Power point presentation, animated videos

- ∉ Lab component/ Practical topics: Induction Motor (Project lab)
- ∉ Links: Motor https://www.youtube.com/watch?v=leXNHZM-CZE
- ∉ Links: Converters https://www.youtube.com/watch?v=7CReXeMAXHA

Unit V

EV charging and Technology Trends in EV –Methods of charging: conductive, inductive and battery swapping, AC charging, DC charging, thermal management for motor, Smart EV Charging, Working of Advanced Driver Assistance Systems (ADAS), Technical concepts of ADAS and Application.

- ∉ Pedagogy/ Course delivery tools: Chalk and talk, Power point presentation, animated videos
- ∉ Lab component/ Practical topics: Charging
- ∉ Links: Charging https://www.youtube.com/watch?v=tyeSahlzt3Y
- ∉ Links: Smart charging https://www.youtube.com/watch?v=nibU1Iq6g3Y

Text Books:

1. **James** Larminie, John Lowry, Electric Vehicle Technology Explained, John Wiley & Sons Ltd, 2nd ed., 2012
2. K. T. Chau - Electric Vehicle Machines and Drives Design, Analysis and Application-Wiley-IEEE Press (2015).
3. G A Goodarzi, John G Hayes - Electric powertrain _ energy systems, power electronics & drives for hybrid, electric & fuel cell vehicles (2018, John Wiley & Sons)
4. Christopher D. Rahn, Chao Yang Wang - Battery Systems Engineering,2013 edition, John Wiley and Sons Ltd.

Reference Books:

1. **C.C. Chan and K.T. Chau,** Modern Electric Vehicle Technology, Oxford University Press, 2001.
2. **Ali Emadi,** Handbook of Automotive Power Electronics and Motor Drives, CRC Press Taylor & Francis Group, 2005
3. **Iqbal Hussein,** Electric and Hybrid Vehicles: Design Fundamentals, CRC Press Taylor & Francis Group, 2003**.**

Web links and video lectures (e-Resources):

1. https://www.youtube.com/watch?v=V004WUdpHeA&list=PLlYm0-AHZdZRLYSylFinxkspWmcgNvbtl
2. https://www.youtube.com/watch?v=Ig5CeBs95_g&list=PLlYm0-AHZdZRLYSylFinxkspWmcgNvbtl&index=4
3. https://www.youtube.com/watch?v=T5P9b0_Fv6w&list=PLlYm0-AHZdZRLYSylFinxkspWmcgNvbtl&index=3
4. https://www.youtube.com/watch?v=403xVzVHgEQ&list=PLlYm0-AHZdZRLYSylFinxkspWmcgNvbtl&index=6
5. https://www.youtube.com/watch?v=8JrZ0x3zPVU

Course Outcomes (COs):

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

1. Understand the development of EV technology over the years and also its suitability in different areas of transportation. (PO1, 3, 6, 11 & PSO1).
2. Learn the important components in an EV and different power train systems (PO1, 9& PSO1)
3. Identify and categorize the different parts and systems necessary for smooth and hassle-free operation of EV (PO1, 3,5& PSO1)
4. Reflect upon the need to improve the charging system and infrastructure in terms of faster charging rate and wider coverage (PO1, 3, 5, 6& PSO2)
5. Learn effective battery management systems and compare the EV technology with other prevalent technologies like fuel cells for automotive applications (PO1,2,5, 6,7 & PSO1,2)

Course Assessment and Evaluation:

Continuous Internal Evaluation (CIE): 50 Marks		
Assessment tool	**Marks**	**Course outcomes addressed**
Internal test-I	30	CO1 &CO2
Internal test-II	30	CO3, CO4 & CO5
Average of the two internal tests will be considered for evaluation of 30 Marks		
Other components- 20 Marks		
Assignment	10	CO1, CO2, CO3
Quiz	10	CO4 & CO5
Semester End Examination (SEE): 100 Marks		
Semester End Examination	100	CO1, CO2, CO3, CO4 & CO5

THEORY OF ELASTICITY	
Course Code: MEE556	**Credits: 3:0:0**
Pre – requisites: Nil	**Contact Hours: 45L+45S**
Course Coordinator: Dr. Mahantesh S Matur	

Course Content

Unit I

Definition and Notations: Stress, Stress at a point, equilibrium equations, equality of cross shear stress, principal stress, octahedral stress, boundary condition equations, stress on an inclined plane.

- Pedagogy/Course delivery tools: Chalk and talk, Power point presentation
- Lab component/ Practical topics: Material Testing Laboratory
- Links: principal stress, octahedral stress https://www.youtube.com/watch?v=9a5lI7rc6fA
- Links: stress on an inclined plane https://www.youtube.com/watch?v=dPS-ayLYcJg

Unit II

Strain at a Point Compatibility equations, principal strains, Mohr's Diagram Generalized Hooke's Law, Plane stress and Plain Strain, Aeris Stress Function, Analysis of beams, cantilever beam.

- Pedagogy/ Course delivery tools: Chalk and talk
- Lab component/ Practical topics: Design and Dynamics Laboratory
- Links:Compatibility equations, principal strains, Mohr's Diagram Generalized Hooke's Law https://www.youtube.com/watch?v=m8Z0ObvSVxM
- Links: Plane stress and Plain Strain, Aeris Stress Function, Analysis of beams, cantilever beam https://www.youtube.com/watch?v=P5jlJ6_joQ8

Unit III

General Equation in Cylindrical Coordinators, Equilibrium equations, analysis of thick cylinder subjected to internal and external pressure, shrink fits.

- Pedagogy/ Course delivery tools: Chalk and talk, Power point presentation.
- Lab component/ Practical topics: Material Testing Laboratory
- Links: General Equation in Cylindrical Coordinators https://www.youtube.com/watch?v=NS8Y8tiMACI
- Links: analysis of thick cylinder subjected to internal and external pressure https://www.youtube.com/watch?v=EpKT-jySYIU

Unit IV

Stresses in Rotating Discs and Cylinders, Stress Concentration in an infinite plate. Thermal Stresses, Thermo elastic stress strain relation, thermal stresses in thick circular disc and long cylinders.

- Pedagogy/ Course delivery tools: Chalk and talk, Power point presentation.
- Lab component/ Practical topics: FEA Laboratory
- Links: Stresses in Rotating Discs and Cylinders https://www.youtube.com/watch?v=J1Q8ssJikOc
- Links: Thermal stresses in think circular disc and long cylinders https://www.youtube.com/watch?v=JCEIQqcmYGY

Unit V

Principal of superposition theorem, Saint Venant's principle, uniqueness theoretician of circular, elliptical and triangular bar, membrane analogy

- Pedagogy/ Course delivery tools: Chalk and talk, Power point presentation.
- Lab component/ Practical topics: FEA Laboratory.
- Links: Saint Venant's principle, uniqueness theoretician of circular https://www.youtube.com/shorts/l2zd41swi0M
- Links: Membrane analogy https://www.youtube.com/watch?v=bf8_rkcKrdQ

Text Books:

1. Theory of Elasticity – SP Timoshenko and Goodier, Mc Graw Hill International, 3rd Edition 1972
2. Advanced Mechanics of Solids – L S Srinath – Tata Mc Graw Hill.

Reference Books:

1. Applied Elasticity – CT Wang, Mc Graw Hill Book 1953
2. Elasticity Theory applications and numericals – Martin H Sadd, Elsiver 2005

Course Outcomes (COs):

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

1. Evaluate and compare the conventional strength of material approach and that of TOE (PO1, 2, 3, 4, and PSO1 &2)
2. Compile fundamentals of TOE for engineering applications. (PO1,2,3,4, PSO1 &2)
3. Develop ability to identify a problem and apply the fundamental concepts of TOE. Demonstrate the ability to solve problems of practical interest. (PO1,2,3,4, PSO1 &2)
4. Develop competence to design and analyze problems of engineering involving design of components (PO1, 2, 3, 4, 5 and PSO1 &2)
5. Demonstrate ability to have the competence for undergoing knowledge up gradation in the field of TOE with particular reference to Theory of Plasticity and Finite Element Method. (PO1, 2, 3, 4, 5, PSO1 &2)

Course Assessment and Evaluation

Continuous Internal Evaluation (CIE): 50 Marks		
Assessment tool	**Marks**	**Course outcomes addressed**
Internal test-I	30	CO1 &CO2
Internal test-II	30	CO3, CO4 & CO5
Average of the two internal tests will be considered for evaluation of 30 Marks		
Other components- 20 Marks		
Assignment	10	CO1,CO2, CO3
Quiz	10	CO4 & CO5
Semester End Examination (SEE): 100 Marks		
Semester End Examination	100	CO1,CO2, CO3, CO4 & CO5

INDUSTRIAL DESIGN AND ERGONOMICS	
Course Code: MEE557	**Credits: 3:0:0**
Pre – requisites: Nil	**Contact Hours: 45L+45S**
Course Coordinator: Dr. Sunith Babu L	

Course Content

Unit I

INTRODUCTION: AN Approach to Industrial Design, elements of a design structure for industrial design in engineering application in modern manufacturing systems.

Office Ergonomics – Working Posture, Workstation Design, Trials, Training, Environment, Manual Handling, Work Related Ill Health.

- Pedagogy/Course delivery tools: Chalk and talk, Power point presentation, animated videos
- Links: https://youtu.be/qG_clin0Tis

Unit II

Ergonomics in Vehicle: Approach, Problem-Solving, Economic Research Studies, Engineer's Importance, Software tools, Responsibilities, History, Importance, Software tools for ergonomics

Controls Displays and Interior Layout _ Control and Display Interface, Types of controls and displays, in vehicle display, Design considerations, visuals, controls, methods to evaluate controls and displays. Examples. Controls and Displays in Machine Tools, Instruments and Cockpit.

- Pedagogy/ Course delivery tools: Chalk and talk, Power point presentation, animated videos, Demonstration using IC engine models
- Links: https://youtu.be/ZU9pYim15fI

Unit III

VISUAL EFFECTS OF LINE AND FORM: The mechanics of seeing-psychology of seeing general influences of line and form.

COLOR: COLOR and light, color and objects-color and the eye-color consistency-color terms reactions to color and color continuation-color on engineering equipment Case Study

- Pedagogy/ Course delivery tools: Chalk and talk, Power point presentation, animated videos
- Links: https://youtu.be/ne--KVwOgUk

Unit IV

AESTHETIC CONCEPTS: Concept of Unity-concept of order with variety-concept of purpose style and environment _Aesthetic expressions. Style _components of style house style, observation style in capital goods, case study.

- Pedagogy/ Course delivery tools: Chalk and talk, Power point presentation, animated videos
- Links: https://youtu.be/XL6xdFnE_LM

Unit V

INDUSTRIAL DESIGN IN PRACTICE: General design specifying design equipment"s, rating the importance of industrial design, industrial design in the design process. Case Study

- Pedagogy/ Course delivery tools: Chalk and talk, Power point presentation, animated
- videos Links: https://youtu.be/-1ql97es4Lc

Text Books:

1. Introduction to Ergonomics, R. C. Bridger, McGraw Hill Publications.
2. Industrial Design for Engineers, Mayall W. H. London Hiffee Books Ltd., 1988
3. Ergonomics in the Automotive Design Process _ Vivek D Bhise, CRC Press, T&F 978-1-4398-4211-9(eBook -PDF)
4. Office Ergonomics, Practical Applications, Celine McKeown – CRC Press, T&F Group,

Reference Books:

1. Human Factor Engineering: Sanders & McCormick McGraw Hill Publications.
2. Applied Ergonomics Hand Book, Brain Shakel, Butterworth Scientific, London 1988

Web links and video lectures (e-Resources)

1. https://www.digimat.in/nptel/courses/video/107103004/L01.html
2. http://www.digimat.in/nptel/courses/video/107103004/L39.html
3. https://nptel.ac.in/courses/107103004

Course Outcomes (COs):

After completing this course, students should be able to:

1. Understand the fundamentals of industrial design and the importance of ergonomics in engineering applications, specifically in modern manufacturing systems. (PO1, PO2, PO3, PO11, PSO1, PSO2)
2. Apply ergonomic concepts in the automotive design process, with a focus on control and display interfaces (PO1, PO2, PO11, PSO1, PSO2)
3. Analyze the visual effects of line and form, and understand the psychology of seeing. (PO1,2,11, PSO1,2).
4. Understand and apply aesthetic concepts, identify and analyze the components of style and adapt their designs to suit specific contexts and audiences (PO1,2,7, PSO 1,2)
5. Apply industrial design principles in practical situations, effectively integrating industrial design into the overall design process. (PO1,2,11, PSO1,2)

Course Assessment and Evaluation:

Continuous Internal Evaluation (CIE): 50 Marks		
Assessment tool	**Marks**	**Course outcomes addressed**
Internal test-I	30	CO1 & CO2
Internal test-II	30	CO3, CO4 & CO5
Average of the two internal tests will be considered for evaluation of 30 Marks		
Other components- 20 Marks		
Assignment	10	CO1,CO2, CO3
Quiz	10	CO4 & CO5
Semester End Examination (SEE)	100	CO1,CO2, CO3, CO4 & CO5

Refrigeration and Advanced Cooling Techniques	
Course Code: MEE 558	**Credits: 3:0:0**
Pre – requisites: BTD & ATD	**Contact Hours: 45L+45S**
Course Coordinator: Gururaj Lalagi	

Unit I:

Introduction to VCR, Methods for improving the COP, Single Load system, multiload systems with compressor, Dual compression system. Presentation of different processes on the P-H chart, Advantages and disadvantages of the refrigeration system

Pedagogy/Course delivery tools: Chalk and talk, Power point presentation

Link: https://www.youtube.com/watch?v=gKC5IpeBDaM

Link 2: https://www.youtube.com/watch?v=474sNpYYWSY

Unit II:

Vapour absorption refrigeration system, NH_3-H_2O and LiBr-H_2O systems, Comparison of VCRS and VARS, Steam jet refrigeration system, Air refrigeration system, Thermoelectric refrigeration (introduction).

Pedagogy/Course delivery tools: Chalk and talk, Power point presentation

Link 1: https://www.youtube.com/watch?v=5hX_horusNM

Link 2: https://www.youtube.com/watch?v=rT_albDoIEI

Unit III:

Properties and selection of refrigerants, ODP and GWP concepts, Alternative refrigerants, Compressors: types and applications, Condensers and evaporators, Expansion devices

Pedagogy/Course delivery tools: Chalk and talk, Power point presentation

Link 1: https://www.youtube.com/watch?v=U7vQhT3NZqA

Link 2: https://www.youtube.com/watch?v=8Fre7oq2onk

Unit IV:

Heat generation in electronic devices, Air cooling techniques for electronics, Liquid cooling methods for CPUs and GPUs, Heat sinks, heat pipes, vapor chambers, Thermal interface materials, Reliability and thermal management challenges

Pedagogy/Course delivery tools: Chalk and talk, Power point presentation

Link 1: https://www.youtube.com/watch?v=I3Gv4bSosL8

Link 2: https://www.youtube.com/watch?v=WYsHDkyP9XM&list=PLPxgRjStIAEwdtTjgAja5ypjZRCJIrNZ6

Unit V:

Thermal challenges in data centers, Hot aisle and cold aisle containment, Immersion cooling techniques, Direct-to-chip liquid cooling, AI, HPC, and server cooling requirements, Energy efficiency metrics: Power Usage Effectiveness (PUE), Water Usage Effectiveness (WUE)

Pedagogy/Course delivery tools: Chalk and talk, Power point presentation

Link 1:https://www.youtube.com/watch?v=D3DLVE5iwl4&list=PLAj7mW3Fc13hkG2gR4QbzVP4IlGd0xZIm

Link 2: https://www.youtube.com/watch?v=UcdRcXjv1xQ&list=PLdyHGcfpoue_8w5NR26Y1h76p388BwbCf

Text Books

1. C.P. Arora – Refrigeration and Air Conditioning, Tata McGraw-Hill.
2. R.S. Khurmi & J.K. Gupta – Refrigeration and Air Conditioning, S. Chand.
3. S.C. Arora and S. Domkundwar- A Course in Refrigeration and Air Conditioning.
4. K. S. Suman-Thermal Management of Electronic Systems
5. Yogendra Joshi & Pramod Kumar- Introduction to Thermal Management

Reference Books

Course Outcomes (COs)

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

CO1: Explain the principles and performance of vapour compression refrigeration systems and analyze methods for improving the coefficient of performance (COP) of refrigeration cycles. (PO1, PO2, PO3)

CO2: Compare vapour absorption refrigeration systems with vapour compression systems and explain the operating principles of alternative refrigeration systems used in engineering applications.(PO1, PO2, PO3, PO6)

CO3: Select appropriate refrigerants and refrigeration system components based on thermodynamic, environmental, and application-specific requirements. (PO1, PO2, PO5, PO6, PSO1, PSO2)

CO4: Analyze thermal management techniques used for electronic devices, CPUs, GPUs, and other high-power electronic systems using appropriate cooling technologies. (PO1, PO2, PO3, PO4, PO5, PO6, PSO1, PSO2)

CO5: Evaluate advanced cooling techniques employed in modern data centers, including immersion cooling, direct-to-chip cooling, and energy-efficient thermal management practices for AI and high-performance computing (HPC) applications (PO2, PO3, PO4, PO5, PO6, PO11, PSO2)

Course Assessment and Evaluation:

Continuous Internal Evaluation (CIE): 50 Marks		
Assessment tool	**Marks**	**Course outcomes addressed**
Internal test-I	30	CO1 & CO2
Internal test-II	30	CO3, CO4 & CO5
Average of the two internal tests will be considered for evaluation of 30 Marks		
Other components- 20 Marks		
Assignment	10	CO1, CO2 & CO3
Quiz	10	CO4 & CO5
Semester End Examination (SEE): 100 Marks		
Semester End Examination	10	CO1, CO2, CO3, CO4 &CO5

VI SEMESTER

MANAGEMENT AND ENTREPRENEURSHIP	
Subject Code: AL61	**Credits: 3:0:0**
Pre requisites: Nil	**Contact Hours: 45L+45S**
Course Coordinator(s): Dr. M Shilpa/Dr. D K Vishwas	

Course Content

Unit I

Introduction to Management: Definition of Management, Its nature and purpose, Contributions of F.W. Taylor and Henry Fayol to management theory, Functions of managers.
Planning: Types of plans, Steps in planning, the planning process, Management by Objectives (MBO)
Organizing: The nature and purpose of organizing, Formal and informal organization. Organization levels and Span of management, Principle of span of management, the structure and process of organizing

- Pedagogy: Chalk and Talk, PowerPoint Presentations
- Links: https://onlinecourses.nptel.ac.in/noc23_mg33/preview
- https://www.digimat.in/nptel/courses/video/110107150/L01.html

Unit II

Staffing: Situational factors affecting staffing.
Leading: Human factors in managing, definition of leadership, Ingredients of leadership
Controlling: Basic control process, Critical control points and standards, Control as a feedback system, Feed forward control, Requirements for effective controls.

- Pedagogy: Chalk and Talk, PowerPoint Presentations
- Links: https://nptel.ac.in/courses/110107150

Unit III

Introduction to Entrepreneurship: The Foundations of Entrepreneurship: What is an Entrepreneurship? The benefits of Entrepreneurship, The potential drawbacks of Entrepreneurship; Inside the Entrepreneurial Mind: From Ideas to Reality: Creativity, Innovation and Entrepreneurship, Creative Thinking, Barriers to Creativity

- Pedagogy: Chalk and Talk, PowerPoint Presentations
- Links:https://www.youtube.com/watch?v=Hgj_kRrvbhQ&list=PL7oBzLzHZ1wXW3mtolxV5nIGn48NLKwrb

Unit IV

The Entrepreneurial Journey: Crafting a Business Plan: The benefits of creating a business plan, the elements of a business plan; Forms of Business Ownership and Buying an Existing Business: Sole proprietorships and partnership.
Launching the Business: Franchising and the Entrepreneur: Types of Franchising, the benefits of buying a Franchise

- Pedagogy: Chalk and Talk, PowerPoint Presentations
- Links:https://www.youtube.com/watch?v=Tzzfd6168jk&list=PLyqSpQzTE6M8EGZbmNUuUM7Vh2GkdbB1R
  https://www.youtube.com/watch?v=5RMqxtMwejM&list=PLyqSpQzTE6M9zMKj_PSm81k9U8NjaVJkR

Unit V

Small Scale Industry: Definition, Characteristics, types, role of SSI in Economic Development, steps to start SSI- Govt. Policy towards SSI, Institutional support- TECKSOK, KIADB, KSSIDC, KSIMC, DIC, NSIC, SIDBI, KSFC.

- Pedagogy: Chalk and Talk, PowerPoint Presentations
- Links:https://www.nptel.ac.in/courses/110/105/110105067/

Text Books:

1. Harold Koontz, H. Weihrich, and A.R. Aryasri, Principles of Management, Tata McGraw-Hill, New Delhi, 2004.
2. Essentials of Entrepreneurship and Small Business Management – Norman Scarborough & Jeffrey Cornwall (Pearson, 2016)
3. Management and Entrepreneurship by K. R. Phaneesh, Sudha Publications, Bangalore

References

1. Innovation & Entrepreneurship – Peter Drucker (Harper, 2006)
2. Entrepreneurship: The Art, Science, and Process for Success – Charles Bamford & Garry Bruton (McGraw-Hill, 2015)
3. Managent and Enterpreneuship-NVR Naidu, T Krishna Rao, I.K. International Publishing House Pvt. Ltd.@ 2008
4. Poornima M Charantimath, Entrepreneurship Development and Small Business Enterprises, Pearson Education, 2006.

Course Assessment and Evaluation:

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

1. Apprehend the planning and organizing functions of management (PO-6,9,11)
2. Identify the enabling factors for staffing, leading and controlling functions in an organization. (PO-6,8,9,10)
3. Analyze the advantages and potential drawbacks of Entrepreneurship. (PO-6,7,8)
4. Develop a basic business plan and analyze the benefits of buying Franchise. (PO-3,5,7,8,11)
5. Identify the various institutions that provide financial support to small scale industries. (PO-6,11)

Continuous Internal Evaluation (CIE): 50 Marks		
Assessment Tool	**Marks**	**Course outcomes addressed**
Internal test-I	30	CO1, CO2
Internal test-II	30	CO3, CO4, CO5
Average of the two internal tests shall be taken for 30marks.		
Other components		
Quiz	10	CO1, CO2,CO3
Assignment	10	CO1, CO2, CO3, CO4, CO5
Semester End Examination (SEE)	100	CO1, CO2, CO3, CO4, CO5

FINITE ELEMENT ANALYSIS	
Course Code: ME62	**Credits: 3:1:0**
Pre – requisites: Nil	**Contact Hours: 45L+30T+45S**
Course Coordinator: Dr. Lokesha	

Course Content

Unit I

Introduction: Equilibrium equations in elasticity subjected to body force, Traction force, Stress - strain relations for plane stress and plane strain, Principle of minimum potential energy. Introduction to Rayleigh-Ritz and Galerkins methods (without numerical). Convergence criteria, Pascal's triangle, geometric isotropy. General Description of Finite Element Method, Advantages, Basic steps in the formulation of Finite Element Analysis.

- Pedagogy/Course delivery tools: Chalk and talk, Power point presentation, animated videos
- Links https://youtu.be/WwgrAH-IMOk

Unit II

Shape functions of Linear simplex element, co- ordinate systems, Stiffness matrix by potential energy approach, Load vector, Elimination approach and Penalty approach of handling boundary conditions, Temperature effect Quadratic Shape Functions of 1D Elements, Problems on stepped bar subjected to axial and thermal loads.

Truss Element: Truss element, Local and Global coordinate systems, Elemental stiffness matrix, Element stress, Temperature effects, Problems on trusses.

- Pedagogy/Course delivery tools: Chalk and talk, Power point presentation, animated videos
- Links https://youtu.be/GHjopp47vvQ

Unit III

Shape functions of CST element, isoparametric representation of CST element, Four node quadrilateral element, Stiffness matrix, Element stress, Lagrangian interpolation functions, Higher order elements, six nodes triangular element, eight nodes quadrilateral element. Numerical Integration using one, two and three point's Gaussian quadrature formula.

- Pedagogy/Course delivery tools: Chalk and talk, Power point presentation, animated videos
- Links https://youtu.be/uXod5l-jNgk
  https://youtu.be/OIxenyV6zNs

Unit IV

Beam element: Beam element, Hermit shape function, Stiffness matrix, Load vector, Shear force and Bending moment, Problems on beams.

- Pedagogy/Course delivery tools: Chalk and talk, Power point presentation, animated videos
- Links https://youtu.be/-qNFGxjXx-s

Unit V

Equation of motion for 1D element, derivation of element mass and stiffness matrices, Eigen value and Eigen vector problems for bar subjected to axial vibrations.

- Pedagogy/Course delivery tools: Chalk and talk, Power point presentation, animated videos
- Links https://youtu.be/rz0mRu-FKV0

Text Books:

1. Finite Element in Engineering, Chandrupatla T.R., 2nd Edition, PHI,2000
2. The Finite Element Method in Engineering, S.S. Rao, 4th Edition, Elsevier, 2006

Reference Books:

1. Text book of Finite Element Analysis, P.Seshu, PHI India, 2004
2. Finite Element Method, J.N. Reddy, McGraw- Hill International Edition.
3. Finite Element Analysis, C.S. Krishnamurthy, Tata McGraw Hill Publishing Co. Ltd, New Delhi, 1995

Web links and video lectures (e-Resources):

1. https://youtu.be/KR74TQesUoQ
2. https://youtu.be/oNqSzzycRhw?list=PLD4017FC423EC3EB5
3. https://youtu.be/F6tQ-_nZevY
4. https://youtu.be/fWOa8re0CLk
5. https://youtu.be/RRB83Z1zyCU

Course Outcomes (COs):

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

1. Apply concepts of theory of elasticity, principle of minimum potential energy variational and weighted residual methods and describe finite element method. (PO1,2,3,4,5, 7, PSO1 &2)
2. Explain and evaluate one dimensional bar and truss problems. (PO1,2,3,4,5, 7, PSO1 &2)
3. Apply fundamentals of two dimensional elements and higher order elements and develop skill to solve related problems. (PO1,2,3,4,5,7,PSO1 & 2)
4. Apply the fundamentals of Beam elements and have skill to solve beam related problems. (PO1,2,3,4,5,7,PSO1 &2)
5. Describe and evaluate dynamic problems of vibrating one dimensional members. (PO1,2,3,4,5,7,PSO1 &2)

Course Assessment and Evaluation

Continuous Internal Evaluation (CIE): 50 Marks		
Assessment tool	**Marks**	**Course outcomes addressed**
Internal test-I	30	CO1 &CO2
Internal test-II	30	CO3, CO4 & CO5
Average of the two internal tests will be considered for evaluation of 30 Marks		
Other components- 20 Marks		
Assignment	10	CO1,CO2, CO3
Quiz	10	CO4 & CO5
Semester End Examination (SEE): 100 Marks		
Semester End Examination	100	CO1,CO2, CO3, CO4 & CO5

FINITE ELEMENT ANALYSIS LABORATORY	
Course Code: MEL65	**Credits: 0:0:1**
Pre – requisites: Nil	**Contact Hours: 30P**
Course Coordinator: Dr. Lokesha	

Conduct the following experiments

1. Bars of constant cross section area, tapered cross section area and stepped bar, Multipoint Constraints, Temperature Stresses in 1D Bars.
2. Trusses.
3. Beams – Simply supported, cantilever beams with UDL, beams with varying load etc.
4. Stress analysis of a rectangular plate with a circular hole subjected to both axial and bending.
5. Thermal Analysis – 2D problem with conduction and convection Boundary conditions.
6. Natural Frequencies of Spring mass and dampers systems of Single and two degrees Systems.
7. Natural Frequencies of fixed – fixed beam.
8. Bars subjected to forcing function.
9. Fixed- Fixed beam subjected to forcing function.

- Pedagogy/ Course delivery tools: Chalk and talk, Power point presentation, animated videos, software demonstration.
- Links
  https://www.youtube.com/watch?v=7qTUut3cPnM&list=PLye_WDkVjjiW6C6D9Qdlc0phBdQz254Pd
  https://youtu.be/AXL4ll3aRB8
  https://youtu.be/OnD77vjsIc4
  https://youtu.be/VJxxnmpVWac
  https://youtu.be/4RwtbDv2II4
  https://youtu.be/1dvEmK6To7M

Text Book:

1. FEA Laboratory Manual-------- By the Department of Mechanical Engineering, MSRIT

Reference Book:

1. Practical Finite Element Analysis ---- Published By Finite to Infinite, Pune, India. ISBN 978-81-906195-0-9

Course Outcomes (COs):

1. Demonstrate the use of FEA tools for different Engineering Problems. (PO1,2, PSO1 &2)
2. Predict the performance of Structural member (PO1,2,3,4, PSO1 &2)
3. Analyze the results obtained from is FEA tool (PO1,2, 5, PSO1 &2)

Course Assessment and Evaluation

Continuous Internal Evaluation (CIE): 50 Marks		
Assessment tool	**Marks**	**Course outcomes addressed**
Internal test	20	CO1, CO2 & CO3
30 Marks Component		
Experiment conduction, calculations and preparation of laboratory Record	30	CO1,CO2 & CO3
Semester End Examination (SEE): 50 Marks		
Semester End Examination	50	CO1, CO2 & CO3

HEAT TRANSFER LABORATORY	
Course Code: MEL66	**Credits: 0:0:1**
Pre – requisites: Heat Transfer	**Contact Hours: 30P**
Course Coordinator: Dr. Niranjan Murthy	

Conduct the following experiments

Conduction Experiments

- Thermal Conductivity of a Metal Rod.
- Overall Heat Transfer Coefficient of a Composite wall.
- Effectiveness on a Metallic fin.
- Transient Conduction Heat Transfer

Convection Experiments

- Heat Transfer Coefficient in a free Convection on a vertical tube.
- Heat Transfer Coefficient in a Forced Convention Flow through a Pipe.
- LMTD and Effectiveness in a Parallel Flow Heat Exchangers
- LMTD and Effectiveness in a Counter Flow Heat Exchangers
- Boiling of Liquid and Condensation of Vapour

Radiation Experiments

- Emissivity of a Surface.
- Stefan Boltzman Constant.

Refrigeration and Air conditioning

- Conduct experiment to determine COP of Refrigeration system
- Demo experiment on Air conditioning test rig

Text Books:

1. Introduction to Heat Transfer by Nikati Ozisik, TATA McGrahill Publications
2. Heat and Mass Trasfer by Rajpoot, Khanna publications

Reference Books:

1. Heat transfer Manual prepared by Department of Mechanical Engineering.
2. Heat and Mass Transfer, 2006., M.Thirumaleshwar, Pearson Edition.
3. Heat and Mass Transfer data book (Seventh Edition) C P Kothandaraman and S Subramanyam
4. Heat and Mass transfer data hand book, R.K Hegde and Niranjan Murthy (sapna Publications)

Web Links And Video Lectures:

1. https://www.youtube.com/watch?v=5NBoje-i9n0
2. https://www.youtube.com/watch?v=0AbbhSU88F0
3. https://www.youtube.com/watch?v=Ry7cJzNHVnE
4. https://www.youtube.com/watch?v=kX24fTA7Dj0

5. https://www.youtube.com/watch?v=B-rFIdOi-No
6. https://www.youtube.com/watch?v=0OqYDSyx0Jk
7. https://www.youtube.com/watch?v=BAlwZYKwQTU
8. https://www.youtube.com/watch?v=ObUspgNMGj8
9. https://www.youtube.com/watch?v=rM23pcV4SNI
10. https://www.youtube.com/watch?v=4lERFvqLZVQ

Course Outcomes (CO):

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

1. Study theoretical aspects of experiments conducted in the Heat transfer laboratory. (PO1, 2, 4, PSO1,2)
2. Evaluate the concept of each and every experiment, along with relevant theory, description, and step by step procedure for conducting experiment**.** (PO1,2,3, 4,5,10, PSO1,2)
3. Describe overall heat transfer co-efficient, local heat transfer coefficient, thermal conductivity of the material and parabolic Trough Solar collector system (PO 1,2,3, 4,5,7,10, PSO1,2)

Course Assessment and Evaluation

Continuous Internal Evaluation (CIE): 50 Marks		
Assessment Tool	**Marks**	**Course Outcomes addressed**
Weekly evaluation of laboratory journals/ reports after the conduction of every experiment	30	CO1,CO2 & CO3
Practical Test	20	CO1,CO2 & CO3
Semester End Examination (SEE)	50	CO1,CO2 & CO3

ROBOTICS	
Course Code: MEE631	**Credits: 3:0:0**
Pre – requisites: Nil	**Contact Hours: 45L+45S**
Course Coordinator: Dr. Sunith Babu L	

Course Content

Unit I

Introduction : Introduction Definition of Robotics, History of Robot, Robot Components, Degree of Freedom, Robot Characteristics, Workspace, Criteria for Defining a Robot; Robot System Integration. Classification of Robots based on Configuration – Construction & Working of Cartesian, Cylindrical, Polar, Jointed-Arm Configuration & SCARA, **Robot Manipulator Configuration**; Types of End-Effectors – Features of Mechanical End-Effectors, Grippers & End-of-Arm Tools

- ∉ Pedagogy/ Course delivery tools: Chalk and talk, Power point presentation
- ∉ Links: https://youtu.be/a4ca04wG-cA
- ∉ Links: https://youtu.be/_canCYWZPsc

Unit II

Sensors : Definition of Sensors; Comparison of Human and Robot Sensing; Types of Robot Sensors – Description and Examples of Proprioceptive, Exteroceptive & Environmental Sensors; Classification of Sensors – Attributes & Examples of Analog & Digital Sensors, Active & Passive Sensors;

Robot Sensors – Working & Attributes of Color & Light Sensor, Ultrasonic & Infrared Sensor, Camera & Image Sensor; Compass Sensor; Force & Tactile Sensor

- ∉ Pedagogy/ Course delivery tools: Chalk and talk, Power point presentation
- ∉ Links: https://youtu.be/27JBnNgn3bc
- ∉ Links: https://youtu.be/J19FkuLNf2w

Unit III

Actuators & Programming : Actuators & Programming Definition of Actuators; General Features of Hydraulic, Pneumatic & Electric Actuators; Criteria for Selection of Actuators for Pick & Place Robots, Welding Robots, Spray Painting Robots Programming of Robots; Types of Programming – Offline Programming, Online programming – Manual and Lead through, **Fanuc Teach Pendant and concepts**; Algorithms & Flow Charts for developing programs for Pick & Place Robots

- ∉ Pedagogy/ Course delivery tools: Chalk and talk, Power point presentation
- ∉ Links: https://youtu.be/9wYkWJeS3lM
- ∉ Links: https://youtu.be/6WrJylGt4Lk

Unit IV

Mobility & Visual Planning : Definition of Mobility & Locomotion; Legged Mobile Robot _ Leg Configuration & Stability; Wheeled Mobile Robots Wheel Configuration & Stability; Description of Robot Maneuverability

Robot Algorithms – Path Planning and Navigation, Localization and Mapping, Motion Control, Perception and Object Recognition, Manipulation and Grasping, Learning and Adaptation, Multi-Robot Coordination. Obstacle Avoidance.

- Pedagogy/ Course delivery tools: Chalk and talk, Power point presentation
- Links: https://youtu.be/9WNE3JAcO6U
- Links: https://youtu.be/gjUT15gm_yg

Unit V

– **Collaborative Robots :** Collaborative Robot – Introduction, Definition, Safety Standards ISO 10218, RIA TS 15066, Collaborative Workspace, Types of Industrial Cobots, - Advantages Collaborative Robot – Introduction, Definition, Safety Standards ISO 10218, RIA TS 15066, Collaborative Workspace, Types of Cobots, Bio-Mechanical Limits, Transient and Quasi Static Impact, AI in robotics: AI-Definition and Scope of AI in Robotics, AI in perception, planning and control, Applications-ROS, OpenCV Machine Learning-Supervised, Unsupervised, and reinforcement Learning Computer Vision-Image Processing, Object Detection, SLAM, Sensor Fusion Robot learning and decision making GQ-CNN.

- Pedagogy/Course delivery tools: Chalk and talk, PowerPoint presentation
- Links: https://www.youtube.com/watch?v=Sb6JjH3Kn34&t=147s
- Links: https://youtu.be/gQMlOFOohjM

Text Books:

1. Robotics for Engineers by Yoram Koren, Mc Graw-Hill
2. Industrial Robotics - Mikell P Groover, Mitchell Weiss, Roger N Nagel and Nicholas G Odrey

Reference Books:

1. Robot Technology by Philippe Coffet (Vol. 1 to Vol. 7)
2. Walking Machines, An introduction to legged Robots by D J Todd
3. Fundamentals of Robot Technology by D J Todd
4. Introduction to Autonomous by Roland Siegwart, Illah R Nourbakhsh, MIT Press, 2004
5. Robot Programming by Cameron Hughes, Tracey Hughes – Pearson Publication, 2015
6. Mars Rover Curiosity by Rob Manning, William L Simon

Course Outcomes (COs):

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

1. **Acquaint** with the basic Configurations, Actuators and Sensors used in Robotic systems. (PO1, 2, PSO1 &2)
2. **Elucidate** the Different Drives and Control Techniques. (PO1, 2, 4,5, PSO1 &2)
3. **Build** customized Robot Programming Sequence for Industrial Applications. (PO1, 2,3,5, 9,10,11, PSO1 &2)
4. Analyze the Robot Mobility and Visual Planning Scenarios and develop appropriate algorithm for a given condition (PO1, 2, 3, 5, 9, 10, 11, PSO1 &2)
5. **Provide** suitable information related to application of cobots in different fields of engineering, medicine, manufacturing (PO1, 3,5,6, PSO1 &2)

Course Assessment and Evaluation:

Continuous Internal Evaluation (CIE): 50 Marks		
Assessment tool	**Marks**	**Course outcomes addressed**
Internal test-I	30	CO1 &CO2
Internal test-II	30	CO3, CO4 & CO5
Average of the two internal tests will be considered for evaluation of 30 Marks		
Other components- 20 Marks		
Assignment	10	CO1,CO2, CO3
Quiz	10	CO4 & CO5
Semester End Examination (SEE): 100 Marks		
Semester End Examination	100	CO1,CO2, CO3, CO4 & CO5

CNC MACHINES	
Course Code: MEE632	**Credits: 3:0:0**
Pre – requisites: Nil	**Contact Hours: 45L+45S**
Course Coordinator: Dr. Jaya Christiyan K G	

Course Content

Unit I

Numerical Control of Machine Tools: Fundamental concepts, Classification and structure of numerical control systems, open and close loop systems, Point systems, positioning cum straight cut systems, continuous path systems, coding Systems, program mediums –tapeformat and codes, interpolators – linear interpolation, Circular interpolation and parabolic interpolation, feedback devices – encoders, linear Scales inductosyn, resolvers.

Drives for CNC Machine Tools: Introduction to drives, spindle drives, Requirements, types of spindle drives – AC drives and DC drives; feed drives – Requirement, servo mechanisms, types of feed drives – stepper motors, DC servo drives, AC servo drives, selection criterionfor drive system.

- Pedagogy/Course delivery tools: Chalk and talk, Power point presentation, animated videos
- Links: https://youtu.be/FNYEXjRmDtI
- Links: https://youtu.be/k4-7t35sLJ8

Unit II

Design of Modern CNC Machines and Manufacturing Elements (Excluding Numerical Problems): Introduction, machine Structures, guide ways – linear motion guides, feed drives, servo motors, mechanical Transmission systems including ball screws. Timer belts, flexible belts, flexible Connections for connection encoders, spindle / spindle bearings, measuring systems. Controls, software and user interface, gauging, tool monitoring systems.

- Pedagogy/ Course delivery tools: Chalk and talk, Power point presentation
- Links: https://youtu.be/tSNVwPqfND8
- Links :https://youtu.be/ONUAah0Fn2E

Unit III

Assembly Techniques: Guide ways, ball screws and nut, feedback elements, spindle bearings.

Introduction to Modern CNC Machines and Manufacturing Systems: Introduction, advantages of CNC Machines, CNC machining center developments, turning center developments, automatic tool changing, tool monitoring on CNC machine, other CNC machine development like adaptive control, advanced manufacturing systems, benefits of FMS, trends in adaptation of FMS systems.

- Pedagogy/ Course delivery tools: Chalk and talk, Power point presentation
- Links: https://youtu.be/WiEDRWyhEik
- Links: https://youtu.be/3MSL7sNooPs

Unit IV

Programming and operation of CNC Machine: Introduction to part programming, co- ordinate systems, dimensioning, axes and motion nomenclature, structure of a part program, word address format, circular interpolation, tool compensation, sub-routines, canned cycles, programming

examples for machining centers, programming for turning center, computer assisted part programming,

- ∉ Pedagogy/ Course delivery tools: Chalk and talk, Power point presentation
- ∉ Links: https://youtu.be/ZgWYoFWTKJc
- ∉ Links: https://youtu.be/4SZ0PtO79Mg

Unit V

Testing of CNC Machine Tools: Introduction, Verification of technical specification, verification of functional aspect, verification during idle running, verification of machine tool accuracy & work piece accuracy, metal removal capability test, safety aspects.

- ∉ Pedagogy/ Course delivery tools: Chalk and talk, Power point presentation
- ∉ Links: https://youtu.be/-jtv9IC6e0I
- ∉ Links: https://youtu.be/6Jnp28O2aeI

Text Books:

1. Computer control of Manufacturing Systems - Yoram Koren, McGraw Hill Intl. Pub.
2. Mechatronics - HMT Ltd., Tata MaGraw Hill Pub.

Reference Books:

1. Numerical control of machine tools - S.J. Martin
2. Computer Numerical Control - Joseph Pusztai and Michael Sava
3. Programming for Numerical Control - Roberts Prentice.
4. Numerical control and Computer Aided Manufacture - Pressman and Williams.
5. CAD/CAM - Mikell P. Groover and Emory W. Zimmers Jr.
6. Introduction to Automated Process Planning System - Tiess Chieu Chang & Richard
7. A. Wysk

Course Outcomes (COs):

1. The student will be able to identify the importance of CNC machines in the modern world (PO1 ,2, 3, 5, 11, PSO1,2)
2. The student will be able to select drives for CNC machines (PO1, 2, 3, 5, 11, PSO1,2)
3. The student will be able to construct the different components of CNC machines (PO1, 2, 3, 5, 11, PSO1,2)
4. The student will be able to write NC part programs for milling and turning (PO1, 2, 3, 5, 11, PSO1,2)
5. The student will be able to assess the CNC machines for various functional parameters (PO1, 2, 3, 5, 11, PSO1,2)

Course Assessment and Evaluation:

Continuous Internal Evaluation (CIE): 50 Marks		
Assessment tool	**Marks**	**Course outcomes addressed**
Internal test-I	30	CO1 &CO2
Internal test-II	30	CO3, CO4 & CO5
Average of the two internal tests will be considered for evaluation of 30 Marks		
Other components- 20 Marks		
Assignment	10	CO1, CO2, CO3
Quiz	10	CO4 & CO5
Semester End Examination (SEE): 100 Marks		
Semester End Examination	100	CO1,CO2, CO3, CO4 & CO5

TOTAL QUALITY MANAGEMENT	
Course Code: MEE633	**Credits: 3:0:0**
Pre – requisites: Nil	**Contact Hours: 45L+45S**
Course Coordinator: Mr. Naveen Kumar B K	

Course Content

Unit I

Over view of Total Quality Management: Introduction, Definition, Basic Approach, Contribution of quality Gurus. Quality circle TQM frame work, Historical review, benefits of TQM, TQM organisation.

Leadership: characteristics of quality leaders, Deming's Philosophy, role of TQM Leaders, continuous processes improvement, Juranas Triology.quality costs

- Pedagogy/Course delivery tools: Chalk and talk, Power point presentation, animated videos
- Links:TQM Leadership https://www.excellup.com/MBA/tqm/tqm_leadership.aspx
- Links: characteristics of quality leaders https://www.ccl.org/articles/leading-effectively-articles/characteristics-good-leader/

Unit II

Tools and techniques of TQM: Basic tools of TQM, Bench marking, processes of bench marking, quality management systems .ISO-9000 series of standards, implementation and documentation of ISO_9000.

Introduction of QFD and QFD process, TQM exemplatory organisation. Design of Failure Mode and Effect analysis [FMEA], process of FMEA.

- Pedagogy/Course delivery tools: Chalk and talk, Power point presentation, animated videos
- Links: Tools and techniques of TQM http://www.siddhabhatta.com/2019/08/tqm-tools-and-techniques-of-total.html
- Links: QFD and QFD process, process of FME https://quality-one.com/qfd/,

Unit III

Statistical Process control (SPC): Seven basic tools of quality control, control charts for variables. construction and interpretation and analysis of control charts process capability indices, process improvement through problem analysis. . (Intensive coverage with numerical problems)

Control charts for attributes: construction, interpretation and analysis of P-chart np-chart-chart and U-chart, improvement through problem analysis .(Intensive coverage with numerical problems)

- Pedagogy/Course delivery tools: Chalk and talk, Power point presentation, animated videos
- Statistical Process control (SPC) process improvement through problem analysis tube.com/watch?v=Sljmwulmrdw
- https://www.techtarget.com/searchcio/definition/business-process-improvement-BPI
- Control charts for attributes https://sixsigmastudyguide.com/attribute-charts/

Unit IV

Product acceptance control: Design of single sampling, double sampling and multiple sampling plan analysis of the characteristics of the SSP, DSP and MSP. . (Intensive coverage with numerical problems)

Operating characteristics curves (OC-Curves): construction, characteristics of OC curves, Terms used in OC curves, LTPD, Outgoing quality Level, {OQL]) , LTPD.AOQ, AOQL etc., (Intensive coverage with numerical problems)

- Pedagogy/Course delivery tools: Chalk and talk, Power point presentation, animated videos
- Links: Product acceptance control https://agileforgrowth.com/blog/acceptance-criteria-checklist/
- Links (OC-Curves): https://study.com/academy/lesson/operating-characteristic-oc-curve-definition-uses.html

Unit V

Reliability and Life Testing: Reliability and analysis of components, standard configurations systems like series, parallel redundancy and principles of design for reliability. reliability testing (Intensive coverage with numerical problems)

Experimental design: One factor design, two factor design, orthogonal design, full factorial and fractional design. Taguchi philosophy of quality engineering, loss function, orthogonal array, sign to noise function, parameter design, tolerance design (Basic concepts and treatment only).

- Pedagogy/Course delivery tools:
- Reliability and Life Testing Chalk and talk, Power point presentation, animated videos
- https://www.test-navi.com/eng/research/handbook/pdf/02_ReliabilityTesting.pdf
- Links: Experimental design: https://byjus.com/maths/experimental-designs/ https://www.scribbr.com/methodology/experimental-design/

Text Books:

1. Total quality Management Dale H Bester field(teal) Pears education, Third edition Indian Reprint -2004
2. Statistical quality Control by Grant Leavenworth (2000)

Reference Books:

1. Stastical quality control by Douglas C Montego third edition Pearson Education -2006
2. A new American TQM for revolution in management: Shoo- Sheba, Alan Graham and, David walder Productivity press Oregon-1990
3. Organizational excellence through TQM H Lal, New Age Publishers
4. Quality control and Total quality management-PL Jain TMH Publications company Ltd - 2001 New Delhi
5. Total quality management and Text cases by Sreedhar Bhat. K Himalaya publishing House edition-1, 2002

Course Outcomes (COs):

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

CO1: Explain the concepts, principles, benefits, organizational structure, leadership requirements, and quality philosophies associated with Total Quality Management. **(PO: 1, 2, 3, 4, 5, 8, 9, 10, 11; PSO: 1&2)**

CO2: Apply quality improvement methodologies such as benchmarking, ISO 9000 standards, Quality Function Deployment (QFD), and Failure Mode and Effect Analysis (FMEA) in engineering and industrial environments. **(PO: 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11; PSO: 1&2)**

CO3: Construct, interpret, and analyze variable and attribute control charts for monitoring and improving process performance using Statistical Process Control techniques. **(PO: 1, 2, 3, 4, 5, 8, 9, 10, 11; PSO: 1&2)**

CO4: Design and evaluate single, double, and multiple sampling plans and analyze Operating Characteristic (OC) curves, AOQ, AOQL, and LTPD for product acceptance decisions. **(PO: 1, 2, 3, 4, 5, 8, 9, 10, 11; PSO: 1&2)**

CO5: Analyze reliability of engineering systems and apply experimental design techniques, including factorial designs and Taguchi methods, to improve product and process quality. **(PO: 1, 2, 3, 4, 5, 7, 8, 9, 10, 11; PSO: 1&2)**

Course Assessment and Evaluation:

Continuous Internal Evaluation (CIE): 50 Marks		
Assessment tool	**Marks**	**Course outcomes addressed**
Internal test-I	30	CO1 &CO2
Internal test-II	30	CO3, CO4 & CO5
Average of the two internal tests will be considered for evaluation of 30 Marks		
Other components- 20 Marks		
Assignment	10	CO1,CO2, CO3,CO4&CO5
Quiz/Presentation/Case study	10	CO1,CO2, CO3,CO4&CO5
Semester End Examination (SEE): 100 Marks		
Semester End Examination	100	CO1,CO2, CO3, CO4 & CO5

ENGINEERING ECONOMY	
Course Code: MEE634	**Credits: 3:0:0**
Pre – requisites: Nil	**Contact Hours: 45L+45S**
Course Coordinator: Dr. Jyothilakshmi. R / Dr.D.K.Vishwas	

Course Content

Unit I

Introduction: Engineering decision makers, engineering and economics, problem solving and decision making, intuition and analysis, tactics and strategy law of demand and supply, law of returns .Interests and interest factors, interest rates, simple interests, compound interests, cash flow diagrams, problems

- Pedagogy/Course delivery tools: Chalk and talk, Power point presentation, animated videos
- Links: Principles of Economics https://youtu.be/ycyMktNFZ88

Unit II

Present worth comparisons: Introduction, Conditions for present worth comparisons, Basic present worth comparison, present worth equivalence, net present worth, assets with unequal lives, assets with infinite lives, future worth comparisons, pay back comparisons, problems.

- Pedagogy/ Course delivery tools: Chalk and talk, Power point presentation, animated videos,
- Links: Present worth, Annual equivalent, Future worth, Internal rate of return https://youtu.be/xiFob1jyIrk

Unit III

Introduction, methods of equivalent annual-worth comparison, situations for EAW comparisons, consideration of asset life, comparisons of assets with equal and unequal lives, use of sinking fund method, annuity contract for guaranteed income, problems.

- Pedagogy/ Course delivery tools: Chalk and talk, Power point presentation, animated videos
- Links: Problem solving on equivalence and comparison of alternatives https://youtu.be/ES5wi-Jty8Y

Unit IV

Rate of return calculations: Introduction, Minimum acceptable rate of return, Internal rate of return, External rate of return, misconceptions about IRR, application of rate of return concept in industries, cost of capital concepts, problems.

Introduction to Industrial Management, contributions of Pioneers – F W Taylors, Frank Gilberth, Henri Fayol, Elton Mayo. Functions of Managements, Levels of Management. Organization, types, functions.

Ownership, types of ownerships, Methods of rising capital.

- Pedagogy/Course delivery tools: Chalk and talk, Power point presentation, animated videos
- Links: Problem solving on frequency compounding of interest and gradient series factors https://youtu.be/Cljoq7c119Q

Unit V

Depreciation: Meaning, causes of depreciation, basic methods of computing depreciation charges, tax concepts, corporate income tax, problems.

Estimating and costing: Introduction, components of costs – direct costs, indirect costs, material cost, labour cost, overheads, etc., Estimation of selling price for simple components, problems.

- ∉ Pedagogy/Course delivery tools: Chalk and talk, Power point presentation, animated videos
- ∉ Links: Depreciation: Units of production method, Depletion https://youtu.be/e_cm-z0137c

Text Books:

1. **Industrial engineering and management** by O.P.Khanna, Danpat Rai and sons 2000
2. **Engineering economics** by Naidu, Babu and Rajendra, New age international Pvt Ltd 2006
3. **Industrial management** by Banga and Sharma Dhanapath rai and sons

Reference Books:

1. **Engineering Economy** by Riggs.J.L, Mcgraw Hill company 2002
2. **Principals of Management** by Koontz O Donnel Mc Grraw Hill Book Company
3. **Engineering Economics** .R by Panner selvam PHI Pvt Ltd New Delhi , 2001

Web links and video lectures (e-Resources):

1. https://youtu.be/xiFob1jyIrk
2. https://youtu.be/xiFob1jyIrk
3. https://youtu.be/ES5wi-Jty8Y
4. https://youtu.be/Cljoq7c119Q
5. https://youtu.be/e_cm-z0137c

Course Outcomes (COs):

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

1. Students should be able to realize the importance of decision making based on financial reasoning. They should be able to clearly understand demand and supply concepts and familiarize themselves with interest and interest factors. (PO1, 2, 6, PSO1,2)
2. Students should understand how to calculate present and future worth of business projects and should be able to compare them while selecting the best based on results. (PO 2, 4, PSO1,2)
3. Students should understand the concept of calculating EMI'S which is part of our real life. They must know how to do the calculations themselves just the way banks would do. (PO 2, 4, PSO1,2)
4. Students especially those who wish to become entrepreneurs should understand the basic concepts of rate of return and its importance in starting new ventures. (PO 1, 2, 11, PSO1)
5. Students should be thorough with the theories of depreciation and their basic calculations since these they appear in all facets of business. They also should understand the elements of costing so that it helps them later in their professional lives. (PO 1, 2, 11, PSO1,2)

Course Assessment and Evaluation:

Continuous Internal Evaluation (CIE): 50 Marks		
Assessment tool	**Marks**	**Course outcomes addressed**
Internal test-I	30	CO1 &CO2
Internal test-II	30	CO3, CO4 & CO5
Average of the two internal tests will be considered for evaluation of 30 Marks		
Other components- 20 Marks		
Assignment	10	CO1,CO2, CO3
Quiz	10	CO4 & CO5
Semester End Examination (SEE): 100 Marks		
Semester End Examination	100	CO1,CO2, CO3, CO4 & CO5

OPERATIONS RESEARCH	
Course Code: MEE641	**Credits: 3:0:0**
Pre – requisites: Nil	**Contact Hours: 45L+45S**
Course Coordinator: Dr. T. Anil Kumar	

Course Content

Unit I

Introduction, Definition, History of OR, Scope of OR, Phases of OR, Characteristics of OR, Limitations of OR, Formulation of LPP, Graphical solutions.Linear Programming Problems-Simplex Method

- ∉ Pedagogy/Course delivery tools: Chalk and talk, Power point presentation
- ∉ Links: Introduction to LPP https://nptel.ac.in/courses/112106134

Unit II

Big M method, Concept of Duality, Finding solution for Primal and Dual problems, Dual Simplex method.

- ∉ Pedagogy/Course delivery tools: Chalk and talk
- ∉ Links: Big M method http://www.nitttrc.edu.in/nptel/courses/video/111107128/L06.html

Unit III

Transportation problems, basic feasible solution, optimality methods, unbalanced problems, maximization problems. Assignment problems Hungarian method, Maximization problem, unbalanced problems.

- ∉ Pedagogy/Course delivery tools: Chalk and talk
- ∉ Links: Transportation problems http://nitttrc.edu.in/nptel/courses/video/110106062/L26.html

Unit IV

Game theory: 2 person zero sum game, Games with and without saddle point, Graphical solutions for 2Xn, mX2 games, Dominance property.
Queueing Theory: Queueing systems and their characteristics, Kendall's notation, Classification of Queueing Models, M/M/1 Queueing system, problems.

- ∉ Pedagogy/Course delivery tools: Chalk and talk
- ∉ Links: Game theory https://www.digimat.in/nptel/courses/video/110101133/L01.html

Unit V

PERT-CPM Techniques: Network construction, Errors in network construction, determining critical path, Floats, Project duration, PERT problems, Crashing of simple networks. (8 hours)

- ∉ Pedagogy/Course delivery tools: Chalk and talk
- ∉ Links: PERT-CPM Techniques
  http://www.nitttrc.edu.in/nptel/courses/video/112106131/L34.html

Text Books:

1. Operations Research- An Introduction by Hamdy A. Taha-Pearson Education Edition.
2. Operations Research- A.P.Verma, S.K.Kataria & Sons, Third edition, 2007

3. Operations Research-S.D. Sharma, Kedarnath Ramnath and Co, 4th edition, 2012
4. Operations Research- Kalavathy.S, Vikas Publishing House, 4th edition 2013
5. Operations Research- R.Panneerselvam, PHI Learning, 2019

Reference Books:

1. Introduction to Operations Research- Hiller and Liberman, McGraw Hill 5th Edition, 2001.
2. Operations Research- A. M. Natarajan, P. Balasubramani, Pearson Education, 2005
3. Operations Research- N.K.Tiwari, Shishir K Shandilya, PHI Learning, 2006
4. Operations Research-Principles and Practice, Ravindran, Philips, Wiley India Ltd, 2nd Edition 2007.
5. Operations Research-Theory and Practice, CRC Press, NVS Raju, 2019

Web links and video lectures (e-Resources)

1. http://www.digimat.in/nptel/courses/video/112106134/L04.html
2. https://nptel.ac.in/courses/111104027
3. https://www.digimat.in/nptel/courses/video/112106134/L16.html
4. http://www.nitttrc.edu.in/nptel/courses/video/111104079/L34.html
5. http://www.digimat.in/nptel/courses/video/110104073/L21.html

Course Learning Outcomes (COs):

1. To formulate a given problem, then to solve either by Graphical/Simplex method. (PO 1, 2, 3,7,9,11, PSO 1, 2)
2. To create the duality property and to discover the optimal solution (PO 1, 2,3,7,9,11, PSO 1, 2)
3. To understand the transportation problems and to identify the best person for assigning the job. (PO 1, 2,3,7,9,11, PSO 1, 2)
4. To evaluate the problems on games theory using graphical and dominance rule, Queuing theory application (PO 1, 2,3,7,9,11, PSO 1, 2)
5. To Analyze the problems on PERT, CPM and crashing; To write a code to solve a problem (PO 1, 2,3,5,7,9,10,11,PSO 1)

Course Assessment and Evaluation:

Continuous Internal Evaluation (CIE): 50 Marks		
Assessment tool	**Marks**	**Course outcomes addressed**
Internal test-I	30	CO1 &CO2
Internal test-II	30	CO3, CO4 & CO5
Average of the two internal tests will be considered for evaluation of 30 Marks		
Other components- 20 Marks		
Assignment	10	CO1,CO2, CO3
Quiz	10	CO4 & CO5
Semester End Examination (SEE): 100 Marks		
Semester End Examination	100	CO1,CO2, CO3, CO4 & CO5

COMPUTATIONAL FLUID DYNAMICS	
Course Code: MEE642	**Credits: 3:0:0**
Pre – requisites: Nil	**Contact Hours: 45L+45S**
Course Coordinator: Dr. Nagesh S N	

Course Content

Unit I

Introduction to CFD: Comparison of Experimental, Theoretical & computational approach, 3-D general mass conversation, Momentum & Energy equation in differential form, Integral form

- Pedagogy/Course delivery tools: Chalk and talk, Power point presentation, animated videos.
- Links: Oxyacetylene welding https://www.youtube.com/watch?v=kwqoyuZTglQ
  https://archive.nptel.ac.in/courses/112/107/112107079

Partial differential equations: Classification physical and mathematical, Equilibrium problems, Marching problems, Hyperbolic, parabolic problems, Elliptic and system of equations.

- Pedagogy/Course delivery tools: Chalk and talk, Power point presentation, animated videos.
- Links: https://www.youtube.com/watch?v=zpxe5yoB0xg
  https://www.youtube.com/watch?v=6cENePu7PBI

Unit II

Basics of numerical methods: Solution of algebraic equations –Gauss elimination, , Crouts method, Solution of ODE, Euler's, Rungekutta Method

- Pedagogy/Course delivery tools: Chalk and talk, Power point presentation, animated videos.
- Links: https://www.youtube.com/watch?v=Zi6YqYDFZQw
  https://www.youtube.com/watch?v=mB6rX-qSRMQ
  https://www.youtube.com/watch?v=yYxwlnilEJs
  https://www.youtube.com/watch?v=Ym1EUjTWMnE

Turbulence modeling: Reynolds averaged Navier-Stokes equations, RANS modeling, DNS and LES.

- Pedagogy/Course delivery tools: Chalk and talk, Power point presentation, animated videos.
- Links: ttps://www.youtube.com/watch?v=zs-sDuoeTVA

Unit III

Basics of Discretization methods: Finite difference equations, Finite difference representation of PDE, Truncation Error, Round off and Discretization error, Consistency, Stability, Convergence criteria.

- Pedagogy/Course delivery tools: Chalk and talk, Power point presentation, animated videos.
- Links: https://www.youtube.com/watch?v=vf0S_1ZITuA
- https://www.youtube.com/watch?v=YTcMTuxNhoE

Unit IV

Application of numerical methods: Heat equation Simple explicit method, Richardson's method, simple implicit method, Laplace equation FD representation, Simple example for Laplace equations.

- ∉ Pedagogy/Course delivery tools: Chalk and talk, Power point presentation, animated videos.
- ∉ Links: https://www.youtube.com/watch?v=gje7QDlmGyU

Unit V

Finite volume Method: Finite volume method for diffusion equation-simple problems, Finite volume method for convection, diffusion equation, steady 1-dimensional convection diffusion, Conservativeness, boundedness, transportiveness, Central differencing schemes, upwind differencing schemes.

- ∉ Pedagogy/Course delivery tools: Chalk and talk, Power point presentation, animated videos.
- ∉ Links: https://www.youtube.com/watch?v=irlI2Rh4dv4
- ∉ https://www.youtube.com/watch?v=t9v5JevUSaM

Text Books:

1. Computational Fluid Mechanics and Heat transfer- 2nd Edition 1998,John C Tannehill, Dule A Anderson, Richard H, Taylor and Francis, UK 2001
2. Numerical Fluid and Heat Transfer, Patankar, 2000

Reference Books:

1. Numerical Methods for Engineers – Iyer and Iyer 2001
2. An Introduction to Computational Fluid Dynamics H K V and W Malalasekera

Course Outcomes (COs):

Students will be able to

1. Explain the fundamental of CFD and to analyze mass, momentum and energy equations. (PO 1, 2, 4, 11, PSO1,2)
2. To solve basic Numerical methods and analyze the equations of turbulence modelling. (PO 1, 2, 3, 4, 5, PSO1,2)
3. To understand the properties of numerical methods and to analyze the equations using finite difference methods (PO 1, 2, 3, 4, 5, PSO1,2)
4. Apply the numerical methods for heat and wave equations using implicit and explicit methods. (PO 1, 2, 3, 4, 5, PSO1,2)
5. Analyze the convection and diffusion problems using finite volume method (PO 1, 2, 3, 4, 5, PSO1,2)

Course Assessment and Evaluation

Continuous Internal Evaluation (CIE): 50 Marks		
Assessment tool	**Marks**	**Course outcomes addressed**
Internal test-I	30	CO1 &CO2
Internal test-II	30	CO3, CO4 & CO5
Average of the two internal tests will be considered for evaluation of 30 Marks		
Other components- 20 Marks		
Assignment	10	CO1,CO2, CO3
Quiz/Assignment	10	CO4 & CO5
Semester End Examination (SEE): 100 Marks		
Semester End Examination	100	CO1,CO2, CO3, CO4 & CO5

NANO TECHNOLOGY	
Course Code: MEE643	**Credits: 3:0:0**
Pre – requisites: Nil	**Contact Hours: 45L+45S**
Course Coordinator: Dr. K.R.V. Subramanian	

Course Content

Unit I

An overview of Nanoscience & Nanotechnology – historical background – multidisciplinary aspects – industrial, economic and societal implications-Applications. NanomaterialsNano materials size effects - Classifications of nanomaterials - Zero dimensional, one-dimensional and two dimensional nanostructures

Nanomaterials for electronics, health, solar, energy storage – Nano oxides in devices like FET, JFET, MOSFET, nano-oxides and nano-polymers in drug delivery and design, cancer therapy, oxides and nitride nanostructures in solar technology, graphene, carbon nanotubes, oxides for energy storage

- Pedagogy/Course delivery tools: Chalk and talk, Power point presentation, animated videos, wood and steel models
- Lab component/ Practical topics: 1 top down approach: Sputtering
  Links: https://www.youtube.com/watch?v=ebO38bbq0_4&ab_channel=nptelhrd
  https://www.youtube.com/watch?v=JffF6AqWCHE&ab_channel=
  EngineeringPhysicsbySanjiv

Unit II

Synthesis of nanomaterials – Overview of top-down and bottom-up techniques. Top down: Ball milling and arc discharge technique. Bottom up: CVD, PVD, ALD, MBE and sol gel technique.

Instruments and Methods – Electron microscopes: SEM and TEM. Scanning probe microscope: atomic force microscopy: x-ray diffraction, Raman spectroscopy, Potentiostat-Galvanostat

- Pedagogy/Course delivery tools: Chalk and talk, Power point presentation, animated videos, Demonstration using XRD, potentiostat-galvanostat
  Lab component/ Practical topics: Demo of XRD
  Links: https://www.youtube.com/watch?v=Z51R49OOqAA&ab_channel=
- BiomedicalNanotechnology
  Links: https://www.youtube.com/watch?v=a0G7iyz4McM&ab_channel=
  ProfessorDaveExplains

Unit III

Fullerenes – discovery, synthesis and purification – chemistry of fullerenes in the condensed phase – orientational ordering – pressure effects – conductivity and superconductivity – ferromagnetism – optical properties-Applications.

Carbon Nanotubes – synthesis and purification – filling of nanotubes – mechanism of growth – electronic structure – transport properties – mechanical and physical properties – carbon nanotube sensors, applications.

- ∉ Pedagogy/Course delivery tools: Chalk and talk, Power point presentation, animated videos, wood models
- ∉ Lab component/ Practical topics: Synthesis of CNT
- ∉ Links: https://www.youtube.com/watch?v=mf5wPBpnRnQ&ab_channel=RightVision https://www.youtube.com/watch?v=CDat0uhQih8&ab_channel=Ekeeda

Unit IV

Graphene – Discovery-electronic structure-synthesis – mechanical, optical and electrical properties – applications.

Mxenes, Chemical Solution Deposition, Cancer nanotechnology

Nanofluids – types, synthesis methods, characterization, vortex creation in nanofluids, application in areas of solar, machining, petroleum, oil recovery

- ∉ Pedagogy/Course delivery tools: Chalk and talk, Power point presentation, animated videos
- ∉ Lab component/ Practical topics: Properties of graphene
  Links: https://www.youtube.com/watch?v=kF1ruTAFLTo&ab_channel=
- ∉ InterestingEngineering
  Links: https://www.youtube.com/watch?v=mJRl6eCMabw&ab_channel=CPI

Unit V

Nano Composites- Introduction to nanocomposites – classification- - properties of nanocomposite materials - synthesis of nanocomposite materials -Applications.

Nanotribology –Introduction- Nanotribometer-Surface force apparatus-quartz crystal microbalance – nano-lubrication- applications.

- ∉ Pedagogy/Course delivery tools: Chalk and talk, Power point presentation, animated videos
- ∉ Lab component/ Practical topics: Synthesis of nanocomposite
  Links: https://www.youtube.com/watch?v=5Zlx6FCbues&ab_channel=NPTEL-NOCIITM
  https://www.digimat.in/nptel/courses/video/118104008/L45.html

Text Books:

1. 1. NANO: The Essentials – Understanding Nanoscience and Nanotechnology; T Pradeep (Professor, IIT Madras); Tata McGraw-Hill India (2007).
2. 2. Nanocomposites Science and Technology - P. M. Ajayan, L.S. Schadler, P. V. Braun 2006.
3. 3. Springer handbook of Nanotechnology – Bharat Bhushan, Springer-Verlag Berlin Heidelberg 2010, 978-3-642-02525-9.

Reference Books:

1. Introduction to Nanoscale Science and Technology [Series: Nanostructure Science and Technology], Di Ventra, et al (Ed); Springer (2004)
2. Nanotechnology Demystified, Linda Williams & Wade Adams; McGraw-Hill (2007)
3. Introduction to Nanotechnology, Charles P Poole Jr, Frank J Owens, Wiley India Pvt. Ltd., New Delhi, 2007.
4. Nanostructures & Nanomaterials: Synthesis, Properties & Applications, G. Cao, Imperial College Press, 2004.

Web links and video lectures (e-Resources):

1. https://www.digimat.in/nptel/courses/video/118104008/L45.html
2. https://www.youtube.com/watch?v=ebO38bbq0_4&ab_channel=nptelhrd

Course Outcomes (COs):

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

1. To understand the nature, scope of the nanotechnology and its interdisciplinary application. (PO1,2,6,11, PSO1, PSO2)
2. Have a thorough knowledge of different synthesis techniques of nano materials and their characterization (PO1,2,4,5,11, PSO1,2) techniques
3. Describe the synthesis and properties of Fullerenes, CNT's and their applications (PO1,2,3,4,5,6,11, PSO 1, 2)
4. To explain the Graphene, Nanofluids: their synthesis, properties and applications (PO1,2,3,4,5,6,11, PSO 1,2)
5. Familiarize the approaches about the nano composite materials, their properties and applications also understand the concept of nanotribology and their applications (PO1,2,3,4,5,6,11, PSO 1,2)

Course Assessment and Evaluation:

Continuous Internal Evaluation (CIE): 50 Marks		
Assessment tool	**Marks**	**Course outcomes addressed**
Internal test-I	30	CO1 &CO2
Internal test-II	30	CO3, CO4 & CO5
Average of the two internal tests will be considered for evaluation of 30 Marks		
Other components- 20 Marks		
Assignment	10	CO1, CO2, CO3
Quiz/ Demonstration of lab component	10	CO1, CO4 & CO5
Semester End Examination (SEE): 100 Marks		
Semester End Examination	100	CO1, CO2, CO3, CO4 & CO5

NON-TRADITIONAL MACHINING	
Course Code: MEE644	**Credits: 3:0:0**
Pre – requisites: Nil	**Contact Hours: 45L+45S**
Course Coordinator: Dr. Mohandas K N	

Course Content

Unit I

Introduction to NTM, Classification of NTM, Comparison between conventional and Non-Traditional process.

Ultrasonic Machining: Introduction, Equipment, Tool material and tool size, Abrasive slurry, cutting tool system design, Effect of parameter: effect of amplitude, frequency, Effect of vibration, abrasive diameter, Effect of applied static load, slurry, tool and work material, USM process characteristics: MRR, tool wear, accuracy, surface finish, Application, advantages and disadvantages of USM.

- Pedagogy/Course delivery tools: Chalk and talk, Power point presentation
- Links: Non-traditional machining https://www.youtube.com/watch?v=jhM01_mwygg
- Links: Ultrasonic machining https://www.youtube.com/watch?v=E4VZ_rFqpG4

Unit II

Abrasive Jet Machining: Introduction, Equipment, Variables in AJM, Carrier gas, types of abrasive, size of abrasive grain, Velocity of the abrasive jet, mean number, abrasive particles/Unit volume of carrier gas, Work material, stand-off distance, nozzle design, shape of cut, Process characteristics: MRR, nozzle wear, accuracy, surface finish, Applications, advantages and disadvantages of AJM.

Water Jet Machining: principle, equipment, operation, Applications, advantages and limitations of WJM.

- Pedagogy/Course delivery tools: Chalk and talk, Power point presentation
- Links: Abrasive Jet Machining https://www.youtube.com/watch?v=FYOsuqdD274
- Links: Water Jet Machining https://www.youtube.com/watch?v=3yV-uJHla58

Unit III

Chemical Machining: Introduction, elements of process, Chemical blanking process: preparation of work piece, Preparation of masters, masking with photo resists, etching for blanking, Accuracy, applications of chemical blanking, chemical milling, Process steps-masking, etching, process characteristics of CHM, MRR, accuracy, surface finish, hydrogen embrittlement, Advantages and application of CHM.

Electro Chemical Machining: Introduction, study of ECM machine, elements of ECM, Cathode tool, Anode work piece, source of DC power, Electrolyte, chemistry of process, ECM process characteristics,-MRR, accuracy, surface finish, ECM tooling: ECM tooling technique and Example, Tool and insulation materials, tool size, electrolyte flow arrangement, Handling of slug, Economics of ECM, applications such as electrochemical turning, Electrochemical grinding, Electrochemical honing, deburring, advantages, limitations.

- Pedagogy/Course delivery tools: Chalk and talk, Power point presentation
- Links: Chemical Machining https://www.youtube.com/watch?v=KfJ85mjpWx4

- Links: Electro Chemical Machining https://www.youtube.com/watch?v=fOc65syJvDM

Unit IV

Electro Discharge Machining: Introduction, Mechanism of material removal, Dielectric fluid, Spark generator, EDM tools, electrode feed control, electrode manufacture, Electrode wear, EDM tool design, choice of machining operation, Electrode material selection, under sizing, length of electrode, machining time, Flushing, pressure flushing, suction flushing, Side flushing, pulsed flushing, EDM process characteristics: MRR, accuracy, surface finish, HAZ, machine tool selection, Application, EDM accessories/ applications, Electric discharge grinding, traveling wire EDM.

- Pedagogy/Course delivery tools: Chalk and talk, Power point presentation
- Links: Electro Discharge Machining https://www.youtube.com/watch?v=rA09KaPL7_8

Unit V

Plasma Arc Machining: Introduction, equipment, nonthermal generation of plasma, Selection of gas, Mechanism of metal removal, PAM parameter, Process characteristics, safety precautions, applications, advantages and limitations.
Laser Beam Machining: Introduction, equipment of LBM, Mechanism of metal removal LBM parameters, process characteristics, Advantages, limitations.
Electron Beam Machining: principles, Equipment, operations, Applications, advantages, limitations of EBM.

- Pedagogy/Course delivery tools: Chalk and talk, Power point presentation
- Links: Plasma Arc Machining https://www.youtube.com/watch?v=kvlBEoLiOGw&t=454s
- Links: Laser Beam Machining https://www.youtube.com/watch?v=mgaukC25Hqk
- Links: Electron Beam Machining https://www.youtube.com/watch?v=pkikv0RHWTA

Text Books:

1. Modern Machining Processes, Pandey, P.C. and Shan, H. S., Tata McGraw Hill Publications (2018).
2. Production Technology, HMT, Tata McGraw Hill, 2010

Reference Books:

1. Advanced Machining Processes, Vijay K Jain, Allied Publishers Mumbai, 2002.
2. Unconventional Manufacturing Process, M K Singh, New Age International, 2010.

Course Outcomes (COs):

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

1. **Recognize** the importance of NTM methods and describe Ultrasonic machining processes. (PO1, 2, 4,5,6,11, PSO1 &2)
2. **Demonstrate** the working principle and applicability of the abrasive jet and water jet machining processes. (PO1, 2,3,4,5,6,11, PSO1,2)
3. **Illustrate** the working principle and applicability of the electro-chemical and chemical machining processes. (PO1, 2, 3,4,5,6,7,11, PSO1 &2)

4. **Describe** the importance of Electro Discharge machining process, aspects related to MRR, surface finish. (PO1, 2,3,4,5,6,11, PSO1 &2)
5. **Illustrate** the working principle, advantages, process limitations of PAM, LBM and EBM processes. (PO1,2,3,4,5,6,7,11, PSO1 &2)

Course Assessment and Evaluation

Continuous Internal Evaluation (CIE): 50 Marks		
Assessment tool	**Marks**	**Course outcomes addressed**
Internal test-I	30	CO1 & CO2
Internal test-II	30	CO3, CO4 & CO5
Average of the two internal tests will be considered for evaluation of 30 Marks		
Other Components - 20 Marks		
Assignment	10	CO1, CO2, CO3
Quiz	10	CO4 & CO5
Semester End Examination (SEE): 100 Marks		
Semester End Examination	100	CO1, CO2, CO3, CO4 & CO5

BASICS TO MACHINE LEARNING AND PYTHON	
Course Code: MEE645	**Credits: 3:0:0**
Pre – requisites: Nil	**Contact Hours: 45L+45S**
Course Coordinator: Dr. Jaya Christiyan K G/ Dr. Rajendra P	

Course Content

Unit I

Introduction, Python interpreter and interactive mode; values and types: int, float, boolean, string, and list; variables, expressions, statements, tuple assignment, precedence of operators, comments; modules and functions, function definition and use, the flow of execution, parameters and arguments. Conditionals: Boolean values and operators, conditional (if), alternative (if-else), chained conditional (if-elif-else); Iteration: while & for.

- Pedagogy/Course delivery tools: Chalk and talk, PowerPoint presentations, animated videos, and Writing python Programs
- Links: Introduction to Python https://www.youtube.com/watch?v=kqtD5dpn9C8
- Links: Python Data Types https://www.youtube.com/watch?v=gCCVsvgR2KU

Unit II

Strings: string slices, immutability, string functions and methods, string module. Lists: list operations, list slices, list methods, list loop, mutability, aliasing, cloning lists, and list parameters. Tuples: tuple assignment, tuple as a return value; Dictionaries: operations and methods

- Pedagogy/ Course delivery tools: Chalk and talk, Powerpoint presentation, animated videos, Writing python Programs
- Links: Strings - Indexing & Slicing https://www.youtube.com/watch?v=IrT_bceIrns
- Links: List Functions https://www.youtube.com/watch?v=S7aghGR0_24

Unit III

What is Machine Learning, what Benefits, opport Unities, and risks for mechanical engineering, Well-posed learning problems, designing a learning system, Perspectives, and Issues, a concept learning task, Concept learning as search, Find-S: Finding a maximally specific hypothesis, Version spaces and candidate elimination algorithm

- Pedagogy/ Course delivery tools: Chalk and talk, Powerpoint presentation, animated videos
- Links: Well-posed learning problems https://www.youtube.com/watch?v=ItQowHSm9W
- Links: Version spaces and candidate elimination algorithm https://www.youtube.com/watch?v=Hr96fzShANk

Unit IV

Decision tree learning: Representation, Appropriate problems for decision tree learning, Basic decision tree learning algorithm, Introduction to Linear and Non-Linear regression

- Pedagogy/ Course delivery tools: Chalk and talk, Powerpoint presentation, animated videos
- Links: Decision tree learning https://www.youtube.com/watch?v=coOTEc-0OGw
- Links: Introduction to Linear and Non-Linear regression https://www.youtube.com/watch?v=rfveCzGqvUA

Unit V

Bayes Theorem and Concept learning, Maximum Likelihood and Least Squared Error, Maximum Likelihood hypotheses for predicting probabilities Bayes Optimal Classifier, Naïve Bayes Classifier, Bayesian Belief Networks, Instance-based learning: k-nearest neighbor learning, locally weighted regression

- Pedagogy/ Course delivery tools : Chalk and talk, Powerpoint presentation, animated videos
- Links: Bayes Theorem and Concept learning
  https://www.youtube.com/watch?v=Fv_LGQKgWi0
- Links: Solved Example Naive Bayes Classifier to classify New Instance Play Tennis
  https://www.youtube.com/watch?v=XzSlEA4ck2I

Text Books:

1. Think Python: How to Think Like a Computer Scientist Allen B. Downey Shroff O'Reilly Publishers 2nd edition 2016 2.
2. An Introduction to Python – Revised and updated for Python 3.2 Guido van Rossum and Fred L. Drake Jr Network Theory Ltd., 2011
3. Tom M. Mitchell, "Machine Learning", McGraw-Hill Education (INDIAN EDITION), 2013

Reference Books:

1. Introduction to Programming in Python: An Inter-disciplinary Approach Robert Sedgewick, Kevin Wayne, Robert Dondero Pearson India Education Services Pvt. Ltd 2016
2. Fundamentals of Python: First Programs Kenneth A. Lambert CENGAGE Learning 2012
3. Ethem Alpaydin, "Introduction to Machine Learning", 2nd Ed., PHI Learning Pvt. Ltd., 2013

Web links and video lectures (e-Resources):

1. https://nptel.ac.in/courses/106106182
2. https://nptel.ac.in/courses/106106145
3. https://onlinecourses.nptel.ac.in/noc22_cs32/preview
4. https://nptel.ac.in/courses/106106139

Course Outcomes (COs):

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

1. Read and write by hand simple Python programs. (PO1, 2, 3, 4 & 5)
2. Outline the preliminaries of machine learning and apply concept learning to real-time scenarios. (PO1, 2, 3, 4 & 5)
3. Illustrate the working of Decision trees. (PO1, 2, 3, 4 & 5)
4. Describe the Bayesian learning algorithm and its variants, Instance-based learning. (PO1, 2, 3, 4 & 5)
5. Investigate concept learning, Bayes classifier, k nearest neighbor, and Regression. (PO1, 2, 3, 4 & 5)

Course Assessment and Evaluation:

Continuous Internal Evaluation (CIE): 50 Marks		
Assessment tool	**Marks**	**Course outcomes addressed**
Internal test-I	30	CO1 &CO2
Internal test-II	30	CO3, CO4 & CO5
The average of the two internal tests will be considered for evaluation of 30 Marks		
Other components- 20 Marks		
Assignment / Quiz	10	CO1,CO2, CO3
Quiz / Assignment	10	CO4 & CO5
Semester End Examination (SEE): 100 Marks		
Semester End Examination	100	CO1,CO2, CO3, CO4 & CO5

HVAC and Thermal Systems Engineering	
Course Code: MEE 646	**Credits: 3:0:0**
Prerequisites: Thermodynamics, Refrigeration, Heat Transfer	**Contact Hours: 45L+45S**
Course Coordinator: Dr. Ashok Kumar K	

Unit I: Fundamentals of HVAC

Introduction to Heating, Ventilation, and Air Conditioning(HVAC)– objectives and scope. Role of HVAC in industrial and commercial buildings. Air conditioning Concepts-Definition, objectives, broad classification and parameters controlled in air conditioning systems. Psychrometry – properties of moist air and representation on psychrometric chart (brief review). Estimation of true air temperature and humidity ratio. Wetted surface heat transfer. Air washers and evaporative cooling systems. Ventilation requirements and its implications in HVAC systems.

- Pedagogy/Course delivery tools: Chalk and talk, Power Point presentations
- Links: https://youtu.be/ExNJoT_2XeI
- Links: https://youtu.be/UKRVxEOD9t0
- Links: https://youtu.be/vd2mPSVqvZ4

Unit II: HVAC Equipment and System Components

Air handling units (AHU) – construction and working. Cooling and heating coils. Air filters – types and applications. Humidifiers and dehumidifiers. Dampers and control devices. Fans and blowers – types, performance characteristics and selection. Chilled water systems – basic components and working. Cooling towers – types and operation. Pumps and hydronic components. Introduction to HVAC control systems and Building Management Systems (BMS).

- Pedagogy/Course delivery tools: Chalk and talk, Power Point presentations
- Links: https://www.youtube.com/watch?v=KCiv8IAUkh8
- Links: https://www.youtube.com/watch?v=zShKFWLoc4I
- Links: https://www.youtube.com/watch?v=UmWWZdJR1hQ

Unit III: Air Conditioning Load Estimation and Sustainable Design

Heat transmission through building envelope – conduction through walls, roof and glass. Solar radiation heat gain and shading devices. Infiltration and ventilation loads. Internal heat gains – occupants, lighting and equipment. Sensible and latent heat estimation. Basic methods of cooling and heating load calculations. Passive air conditioning techniques. ECBC norms. Green building principles. Methods to reduce air conditioning load. Sustainable cooling solutions.

- Pedagogy/Course delivery tools: Chalk and talk, Power Point presentations
- Links: https://www.youtube.com/watch?v=9-K9Y5b8M5c
- Links: https://www.youtube.com/watch?v=0YCyJ1bQ3qo
- Links: https://www.youtube.com/watch?v=XMGIQuArgq0

Unit IV: Air Distribution Systems

Flow through ducts. Static and dynamic losses. Diffusers and air terminals. Duct design – Equal friction method and Static regain method. Duct balancing. Fan–duct interaction. Selection of fans. Introduction to ventilation standards.

- Pedagogy/Course delivery tools: Chalk and talk, Power Point presentations
- Links: https://www.youtube.com/watch?v=zkuAUB_caRY
- Links: https://www.youtube.com/watch?v=WE2LPedFbgA
- Links: https://www.youtube.com/watch?v=c5rPf_eu4BM

Unit V: Industrial and Commercial HVAC Applications

Room air conditioners and packaged air conditioning systems. Centralized air conditioning systems. Chilled water systems and cooling towers in large buildings. Radiant cooling systems. Demand Controlled Ventilation (DCV), Variable Air Volume (VAV) systems, Under Floor Air Distribution (UFAD) systems. Hydronic systems. Air handling systems. HVAC applications in hospitals, malls, cold storage and data centers. Clean room concepts – classification, air cleanliness standards, filtration systems and pressure control. Energy-efficient HVAC systems and energy conservation in buildings.

- Pedagogy/Course delivery tools: Chalk and talk, Power Point presentations
- Links: https://www.youtube.com/watch?v=RkNfzEqnFvc&t=230s
- Links: https://www.youtube.com/watch?v=GzEMdQk1QTk
- Links: https://www.youtube.com/watch?v=IRpn-siMmoI
- Links: https://www.youtube.com/watch?v=ws6-JfBSXGs
- Links: https://www.youtube.com/watch?v=S4VyAOnngAk

Course Outcomes (COs)

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

CO1: Explain HVAC fundamentals, air conditioning concepts, and thermal comfort requirements using psychrometric principles. (PO1, PO2, PO3, PO5, PO6, PO11, PSO1, PSO2)

CO2: Describe and analyze the working of HVAC equipment, chilled water systems, cooling towers, and control systems used in buildings. (PO1, PO2, PO3, PO4, PO5, PO6, PO11, PSO1, PSO2)

CO3: Estimate cooling and heating loads for buildings considering transmission, solar, internal, and ventilation heat gains. (PO1, PO2, PO3, PO4, PO5, PO6, PO11, PSO1, PSO2)

CO4: Apply principles of air distribution to design basic duct systems and select appropriate fans and air handling components. (PO1, PO2, PO3, PO4, PO5, PO6, PO8, PO11, PSO1, PSO2)

CO5: Explain the operation and applications of modern HVAC systems in industrial and commercial buildings, incorporating clean room concepts and energy-efficient practices. (PO1, PO2, PO3, PO5, PO6, PO7, PO8, PO9, PO10, PO11, PSO1, PSO2)

Text Books

1. C.P. Arora and S. Domkundwar, Refrigeration and Air Conditioning, McGraw Hill Education.
2. R.S. Khurmi & J.K. Gupta – Refrigeration and Air Conditioning, S. Chand.
3. S.C. Arora and S. Domkundwar- A Course in Refrigeration and Air Conditioning.
4. R.K. Rajput- A Textbook of Refrigeration & Air Conditioning.
5. Kevin L. Amende, Julia A. Keen, Lynn E. Catlin, Megan Tosh, Andrew M. Sneed, Ronald H. Howell, Principles of Heating, Ventilating, and Air Conditioning, 9th Edition, ASHRAE Publications, 2021.

Reference Books

1. **Faye C. McQuiston, Jerald D. Parker & Jeffrey D. Spitler**, Heating, Ventilating and Air Conditioning: Analysis and Design, Wiley.
2. **John W. Mitchell & James E. Braun**, Principles of Heating, Ventilation and Air Conditioning in Buildings, Wiley.
3. **ASHRAE Handbook – Fundamentals**, ASHRAE Publications.

Course Assessment and Evaluation:

Continuous Internal Evaluation (CIE): 50 Marks		
Assessment tool	**Marks**	**Course outcomes addressed**
Internal test-I	30	CO1 & CO2
Internal test-II	30	CO3, CO4 & CO5
Average of the two internal tests will be considered for evaluation of 30 Marks		
Other components- 20 Marks		
Assignment	10	CO1, CO2 & CO3
Quiz	10	CO4 & CO5
Semester End Examination (SEE): 100 Marks		
Semester End Examination	10	CO1, CO2, CO3, CO4 &CO5

3D PRINTING	
Course Code: MEOE01	**Credits: 3:0:0**
Pre – requisites: Nil	**Contact Hours: 45L+45S**
Course Coordinator: Dr. Jaya Christiyan K G	

Course Content

Unit I

Additive Manufacturing, AM Information work flow, AM – An Integral part of Time compression Engineering, Classification of AM processes (As per ASTM F42), The Benefits of AM, Distinction Between AM and CNC Machining.

Vat Photo Polymerization Processes: Introduction, Photo polymerization Process (SLS), Extrusion-Based Systems: Introduction, Basic Principles, Fused Deposition Modeling process, Materials, Limitations of FDM.

- Pedagogy/Course delivery tools: Chalk and talk, Power point presentation
- Links https://www.youtube.com/watch?v=ICjQ0UzE2Ao
  https://www.youtube.com/watch?v=7jNodHYUQc8

Unit II

Solid Ground curing: Introduction, Basic Principles, SGC Process, Materials. LOM, Binder Jetting process, Benefits and Drawbacks, Applications. CAD Modeling for 3D Printing, Scanning and Digitization data handling process parameter.

- Pedagogy/Course delivery tools: Chalk and talk, Power point presentation
- Links https://www.youtube.com/watch?v=ICjQ0UzE2Ao.

Unit III

Design for Additive Manufacturing: Design for Manufacturing and Assembly, Introduction to Design for Additive Manufacturing, General Guidelines for Designing AM Parts, Design to Minimize Print Time, Design to Minimize Post-processing.

Post-processing: Support Material Removal, Polymer Surface Treatments: Vapour Smoothing, Sand Blasting, Tumbling, Metal Surface Treatments: Shot-Peening, Machining and Grinding, Anodizing, Plasma Spraying, Plating and PVD.

- Pedagogy/Course delivery tools: Chalk and talk, Power point presentation
- Links https://www.youtube.com/watch?v=U0xxd70g0y0
  https://www.youtube.com/watch?v=uuCt_8nGDrM

Unit IV

Powder Bed Fusion: Selective Laser Sintering: Introduction, Process parameter, SLS sintering process, Electron Beam melting (EBM) process.

Directed Energy Deposition Processes: Introduction, General DED Process Description, Material Delivery, DED Systems, Process Parameters, DED Benefits and Drawbacks.

- Pedagogy/Course delivery tools: Chalk and talk, Power point presentation
- Links https://youtu.be/LjWL-lQe6ok

Unit V

Indirect Methods for Rapid Tool Production, Role of Indirect Methods in Tool Production, Metal Deposition Tools, RTV Tools, Epoxy Tools, Direct Methods for Rapid Tool Production: Classification of Direct Rapid Tool Methods, RapidToo1 process, Sand Form, Pattern for Investment and Vacuum Casting, Functional Models.

- Pedagogy/Course delivery tools: Chalk and talk, Power point presentation
- Links https://youtu.be/RQVjwSG1-XY

Text Books:

1. Additive Manufacturing Technologies, I. Gibson l D. W. Rosen l B. Stucker, Springer New York Heidelberg Dordrecht London, 2010.
2. Stereo lithography and other RP & M Technologies, Paul F.Jacobs: "SME, NY 1996.
3. Rapid manufacturing, Fiham D.T & Dinjoy S.S Verlog London 2001.
4. Rapid Prototyping: Principles and Application, by Rafiq I. Noorani

Course Learning Outcomes (COs):

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

1. Understand the working principles and process parameters of additive manufacturing processes (PO1, 2, 4, PSO1,2)
2. Explore different additive manufacturing processes and suggest suitable methods for building a particular component (PO1, 2, 4, PSO1,2)
3. Design and develop a working model using additive manufacturing Processes (PO1, 2, 3, 4, PSO1,2)
4. Understand the working principles and process Metal Additive Manufacturing (PO1, 2, 3, 4, PSO1, 2)
5. Perform suitable Tooling Technique for manufacturing requirement (PO1, 2, 3, 4, PSO1, 2)

Course Assessment and Evaluation:

Continuous Internal Evaluation (CIE): 50 Marks		
Assessment tool	**Marks**	**Course outcomes addressed**
Internal test-I	30	CO1, CO2, CO3
Internal test-II	30	CO3, CO4 & CO5
Average of the two internal tests will be considered for evaluation of 30 Marks		
Other components- 20 Marks		
Project/ Quiz	10	CO1, CO2, CO3, CO4 & CO5
Assignment writing	10	CO1, CO2, CO3, CO4 & CO5
Semester End Examination (SEE): 100 Marks		
Semester End Examination	100	CO1, CO2, CO3, CO4 &CO5

CNC MACHINES	
Course Code: MEOE02	**Credits: 3:0:0**
Pre – requisites: Nil	**Contact Hours: 45L+45S**
Course Coordinator: Dr. Jaya Christiyan K G	

Course Content

Unit I

Numerical Control of Machine Tools: Fundamental concepts, Classification and structure of numerical control systems, open and close loop systems, Point systems, positioning cum straight cut systems, continuous path systems, coding Systems, program mediums –tape format and codes, interpolators – linear interpolation, Circular interpolation and parabolic interpolation, feedback devices – encoders, linear Scales inductosyn, resolvers.

Drives for CNC Machine Tools: Introduction to drives, spindle drives, Requirements, types of spindle drives – AC drives and DC drives; feed drives – Requirement, servo mechanisms, types of feed drives – stepper motors, DC servo drives, AC servo drives, selection criterion for drive system.

- Pedagogy/Course delivery tools: Chalk and talk, Power point presentation
- Links https://youtu.be/FNYEXjRmDtI
  https://youtu.be/k4-7t35sLJ8

Unit II

Design of Modern CNC Machines and Manufacturing Elements (Excluding Numerical Problems): Introduction, machine Structures, guide ways – linear motion guides, feed drives, servo motors, mechanical Transmission systems including ball screws. Timer belts, flexible belts, flexible Connections for connection encoders, spindle / spindle bearings, measuring systems. Controls, software and user interface, gauging, tool monitoring systems.

- Pedagogy/Course delivery tools: Chalk and talk, Power point presentation
- Links https:// youtu.be/tSNVwPqfND8
  https://youtu.be/ONUAah0Fn2E

Unit III

Assembly Techniques: Guide ways, ball screws and nut, feedback elements, spindle bearings.

Introduction to Modern CNC Machines and Manufacturing Systems: Introduction, advantages of CNC Machines, CNC machining center developments, turning center developments, automatic tool changing, tool monitoring on CNC machine, other CNC machine development like adaptive control, advanced manufacturing systems, benefits of FMS, trends in adaptation of FMS systems.

- Pedagogy/Course delivery tools: Chalk and talk, Power point presentation
- Links https://youtu.be/WiEDRWyhEik
  https://youtu.be/3MSL7sNooPs

Unit IV

Programming and operation of CNC Machine: Introduction to part programming, co- ordinate systems, dimensioning, axes and motion nomenclature, structure of a part program, word address format, circular interpolation, tool compensation, sub-routines, canned cycles, programming

examples for machining centers, programming for turning center, computer assisted part programming

- ∉ Pedagogy/Course delivery tools: Chalk and talk, Power point presentation
- ∉ Links https://youtu.be/ZgWYoFWTKJc
  https://youtu.be/4SZ0PtO79Mg

Unit V

Testing of CNC Machine Tools: Introduction, Verification of technical specification, verification of functional aspect, verification during idle running, verification of machine tool accuracy & work piece accuracy, metal removal capability test, safety aspects.

- ∉ Pedagogy/Course delivery tools: Chalk and talk, Power point presentation
- ∉ Links https://youtu.be/-jtv9IC6e0I
  https://youtu.be/6Jnp28O2aeI

Text Books:

1. Computer control of Manufacturing Systems - Yoram Koren, McGraw Hill Intl. Pub.
2. Mechatronics - HMT Ltd., Tata MaGraw Hill Pub.

Reference Books:

1. Numerical control of machine tools - S.J. Martin
2. Computer Numerical Control - Joseph Pusztai and Michael Sava
3. Programming for Numerical Control - Roberts Prentice.
4. Numerical control and Computer Aided Manufacture - Pressman and Williams.
5. CAD/CAM - Mikell P. Groover and Emory W. Zimmers Jr.
6. Introduction to Automated Process Planning System - Tiess Chieu Chang & Richard A. Wysk

Course Learning Outcomes (COs):

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

1. The student will be able to identify the importance of CNC machines in the modern world (PO1,2,3,5, PSO1,2)
2. The student will be able to select drives for CNC machines (PO1,2,3,5, PSO1,2)
3. The student will be able to construct the different components of CNC machines (PO1,2,3,5,PSO1,2)
4. The student will be able to write NC part programs for milling and turning (PO1,2,3,5,PSO1,2)

Course Assessment and Evaluation:

Continuous Internal Evaluation (CIE): 50 Marks		
Assessment tool	**Marks**	**Course outcomes addressed**
Internal test-I	30	CO1, CO2, CO3
Internal test-II	30	CO3, CO4 & CO5
Average of the two internal tests will be considered for evaluation of 30 Marks		
Other components- 20 Marks		
Project/ Quiz	10	CO1, CO2, CO3, CO4 & CO5
Assignment writing	10	CO1, CO2, CO3, CO4 & CO5
Semester End Examination (SEE): 100 Marks		
Semester End Examination	100	CO1,CO2, CO3, CO4 & CO5

SUSTAINABLE WASTE MANAGEMENT TECHNIQUES	
Course Code: MEOE03	**Credits: 3:0:0**
Pre – requisites: Nil	**Contact Hours: 45L+45S**
Course Coordinator: Dr. Jyothilakshmi R	

Course Content

Unit I

Introduction: Present solid waste disposal methods. Merits and demerits of open dumping, incineration, pyrolysis, composting, and sanitary landfill. Scope and importance of solid waste management. Definition and functional elements of solid waste management.

Sources: Sources of Solid waste, types of solid waste, the composition of municipal solid waste, generation rate, Problems. Collection and transportation of municipal solid waste: Collection of solid waste- services and systems, Municipal Solid Waste (Management and Handling) 2016 rules with amendments. Site visit to the collection system

- Pedagogy/Course delivery tools: Chalk and talk, Power point presentation
- Links https://www.youtube.com/watch?v=Wf_Y_Wf5t98
  https://www.youtube.com/watch?v=CVKEyyxLr5I

Unit II

Composting Aerobic and anaerobic composting - process description, process microbiology, Vermicomposting, a Site visit to compost plant, Numerical problems. Sanitary landfilling: Definition, advantages and disadvantages, site selection, methods, reaction occurring in landfill-Gas and Leachate movement, Control of gas and leachate movement, a Site visit to a landfill site.

- Pedagogy/Course delivery tools: Chalk and talk, Power point presentation
- Links https://www.youtube.com/watch?v=w5hvBQDyBL4
  https://www.youtube.com/watch?v=_iSYtGChNfU

Unit III

Hazardous waste management: Definitions, Identification of hazardous waste, Classification of hazardous waste, onsite storage, collection, transfer and transport, processing, disposal, Hazardous and other wastes (Management and Transboundary Movement) Rules, 2016 with amendments. Site visit to a hazardous landfill site.

- Pedagogy/Course delivery tools: Chalk and talk, Power point presentation
- Links https://www.youtube.com/watch?v=epEIjY7_76M
  https://www.youtube.com/watch?v=tIunGBHOI0A

Unit IV

Biomedical waste management: Classification of bio-medical waste, collection, transportation, disposal of biomedical waste, Biomedical waste management (Management & Handling Rules) 2016 with amendments. Site visit to the hospital to observe biomedical waste collection and transportation system and visit to biomedical waste incineration plant.

- Pedagogy/Course delivery tools: Chalk and talk, Power point presentation
- Links https://www.youtube.com/watch?v=mBMCE5Tm25s
  https://www.youtube.com/watch?v=EhaFeWHFfLE

Unit V

E-waste management: Definition, Components, Materials used in manufacturing electronic goods, Recycling, and recovery integrated approach. e-waste (Management) Rules 2016 and amendments. Site visit to the e-waste treatment plant.

Plastic waste management: Manufacturing of plastic with norms. Plastic waste management. Plastic manufacture, sale & usage rules 2009 with amendments.

- Pedagogy/Course delivery tools: Chalk and talk, Power point presentation
- Links https://www.youtube.com/watch?v=x8_pNQZstvE
  https://www.youtube.com/watch?v=8tK5wYmQ8G0

Text Books:

1. Integrated Solid Waste Management, George.C. Tchobanoglous, International edition,1993, McGraw Hill publication. ISBN 978-0070632370
2. Electronic waste management, R.E. Hester, Roy M Harrison, Cambridge, UK, 2009, RSC Publication, ISBN 9780854041121
3. Solid Waste Management Rules 2016, Ministry of Environment, Forest and Climate Change Notification, New Delhi, 8th April 2016

Reference Books:

1. Hazardous and other wastes (Management and Transboundary Movement) Rules, 2016, Ministry of Environment, Forest and Climate Change Notification, New Delhi, 04th April 2016.
2. Biomedical waste management (Management & Handling Rules) 2016, Ministry of Environment & Forest Notification, New Delhi, amendment on 28th March 2016.
3. E-waste (Management) Rules 2016, Ministry of Environment, Forest and Climate Change Notification, New Delhi, 23rd March 2016.
4. Plastic Waste (Management and Handling) Rules, 2011 as amended in 2018, Ministry of Environment, Forest and Climate Change Notification, New Delhi, 27th March 2018

Course Learning Outcomes (COs):

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

1. Understand the current solid waste management system and statutory rules. (PO 1, 2, 4, 5, 6, 7, 8, 9, 11, PSO1, 2)
2. Analyze drawbacks in the present system and provide recycling and disposal options for each type of waste in compliance with rules. (PO 1, 2, 4, 5, 6, 7, 8, 9, PSO1, 2)
3. Distinguish Hazardous, Biomedical, and E-waste and provide a scientific management system. (PO 1, 2, 4, 5, 6, 7, 8, 9, 11, PSO1, 2)
4. Evaluate and monitor the Biomedical, Hazardous, E, and Plastic and Municipal waste management per the Ministry of Environment, Forest, and Climate Change rules. (PO 1, 2, 4, 5, 6, 7, 8, 9, PSO1, 2)
5. Analyze different methods of segregation, handling and processing of E-waste.(PO 1,2,3,5,8,PSO1)

Course Assessment and Evaluation:

Continuous Internal Evaluation (CIE): 50 Marks		
Assessment tool	**Marks**	**Course outcomes addressed**
Internal test-I	30	CO1& CO2
Internal test-II	30	CO3, CO4 & CO5
The average of the two internal tests will be considered for evaluation of 30 Marks		
Other components- 20 Marks		
Assignment	10	CO1, CO2, CO3
Quiz	10	CO4 & CO5
Semester End Examination (SEE): 100 Marks		
Semester End Examination	100	CO1, CO2, CO3, CO4 &CO5

TRADITIONAL INDIAN SCIENCE AND TECHNOLOGY	
Course Code: MEOE04	**Credits: 3:0:0**
Pre – requisites: Nil	**Contact Hours: 45L+45S**
Course Coordinator: Dr. B P Hari Chandra	

Course Content

Unit I

Introduction: Scope, authors of ancient Indian books/theories/formulae, Vedic literature. Introduction to Indian medical sciences and Yoga, Typical nanomedicines in AYUSH systems. Research potentials and ways to promote. Introduction to state of Indian agriculture and agri-business.

- Pedagogy/Course delivery tools: Chalk and talk, Power point presentation
- Links https://www.youtube.com/watch?v=8USA_rMCAO0
  https://www.youtube.com/watch?v=HUzBCts7BTo
  https://www.youtube.com/watch?v=rKStrN1MXv4

Unit II

Materials: Metallurgy: Brozes of South India, Iron and Steel, Zinc and its alloys, alloys and metallurgical technologies, Typical marvels of Indian Iron, Introduction to Rasaratnasamucchaya, removal of impurity (shodhana), nanomaterials-their traditional methods. Research potentials and ways to promote.

- Pedagogy/Course delivery tools: Chalk and talk, Power point presentation
- Links https://www.youtube.com/watch?v=e5iac4Mb9CQ

Unit III

Aeronautics: Rockets and Rocketry, Bharadwaja Vimanashastra. Research potentials and ways to promote**.**

- Pedagogy/Course delivery tools: Chalk and talk, Power point presentation

Unit IV

Astronomy: Time scale, measurement of time, astronomical instruments and observatories. Description of planets, grahas, earth, sun and moon Research potentials and ways to promote.

- Pedagogy/Course delivery tools: Chalk and talk, Power point presentation
- Links https://www.youtube.com/watch?v=imsmeXx7VJc
  https://www.jantarmantar.org/learn/observatories/instruments/index.html

Unit V

Vedic mathematics: Introduction to vedic mathematic sutras, Simple Numerical-Multiplication, division, squares, square roots, cubes, simultaneous equations, Taylor series, Leibnitz power series, modified Leibnitz series, infinite GP. Geometrical studies, magic squares. Value of pi in Indian mathematics. Introduction to siribhuvalaya Research potentials and ways to promote.

- Pedagogy/Course delivery tools: Chalk and talk, Power point presentation
- Links https://www.youtube.com/watch?v=ICjQ0UzE2Ao_v=yUJEi3a6uq8
  https://www.youtube.com/watch?v=imsmeXx7VJc

Text Books:

1. Indian Scientific Heritage – Dr. N Gopalakrishnan, Indian Institute of Scientific Heritage, Thiruvananthapuram, kerala
2. Vymaanikashaastra – Aeronautics by Maharshi Bharadwaaja, translated by G R Josyer, International academy of Sanskrit research.
3. Rasaratna Samuchaya – A D Satpute, Chowkamba Sanskrit Prathistan
4. Encyclopedia of Classical Indian Sciences – Dr. Roddam Narasimhan and Helaine Selin, Vijaykumar Govindram Hasanand Publications, University Press (India) Pvt. Ltd., Hyderabad
5. Faculty Notes .

Reference Books:

1. Founders of sciences in Ancient India – Swamy Sathyaprakash Saraswathi
2. Indian Technological Heritage – Dr. N Gopalakrishnan, Indian Institute of Scientific Heritage, Thiruvananthapuram.
3. Science & Technology in 18th Century, Prof. Dharampal, Other India Press, Mapusa, Goa.
4. Vedic Mathematics – Bharathi Krishna Theertha Swamiji, MBLD Publications, New Delhi.
5. Yoga: Its basis and applications – Dr. H R Nagendra, Swami Vivekananda Yoga Prakashana, Bangalore, India

Course Learning Outcomes (COs):

Through this course, students would have

1. Identified areas where Indians had excelled in Traditional Indian Sciences and Technologies (TISTs) and would be able to identify scope for research in the area. (PO 1, 6,11)
2. Understood some of the traditional metallurgical sciences and technologies and applications of the same; and realize the huge scope for research. (PO 1, 6, 11)
3. Understood various aspects of contribution of Indian literature in the field of aeronautics and rocketry and would have looked into possibility of research thereon. (PO 1, 3, 6, 9,11)
4. An overview of typical aspects of Indian astronomy, time scales and instruments thereon, and identified possibility of research thereon. (PO 1, 6, 11)
5. Understood the contribution of Indians in the field of mathematics, coding and their typical applications, and would have explored possibility of value addition. (PO 6, 11)

Course Assessment and Evaluation:

Continuous Internal Evaluation (CIE): 50 Marks		
Assessment tool	**Marks**	**Course outcomes addressed**
Internal test-I	30	CO1 & CO2
Internal test-II	30	CO3, CO4 & CO5
Average of the two internal tests will be considered for evaluation of 30 Marks		
Other components- 20 Marks		
Assignment	10	CO1, CO2 & CO3
Quiz	10	CO4 & CO5
Semester End Examination (SEE): 100 Marks		
Semester End Examination	100	CO1, CO2, CO3, CO4 &CO5

AUTOMOTIVE ENGINEERING	
Course Code: MEOE05	**Credits: 3:0:0**
Pre – requisites: Nil	**Contact Hours: 45L+45S**
Course Coordinator: Mr. Gururaj Lalagi	

Course Content

Unit I

Introduction: IC Engine, SI & CI engine, Components of an engine, valve timing diagram of 4 stroke engine, cooling and lubrication requirements, methods of cooling and lubrication.

Fuels: Conventional fuels, LPG and Natural gas, alternate fuels like ethanol and ethanol blends, introduction to new fuels for Automotive Engines like hydrogen, hybrid fuels and fuel cells. Normal and abnormal combustion.

- Pedagogy/Course delivery tools: Chalk and talk, Power point presentation
- Lab component/Practical topics: IC Engine lab
- Links https://www.youtube.com/watch?v=XDsUqCgAUHk
  https://www.youtube.com/watch?v=CarS3E_V63Y

Unit II

Fuel supply systems for SI and CI engines: Properties of air-fuel mixtures - Mixture requirements for steady state and transient operation, Fuel Supply system for gasoline and diesel engine. Basic principle of fuel pump, carburetor and fuel injector.

Ignition systems: Battery Ignition systems, magneto Ignition system, Electronic Ignition, Automatic Ignition advance systems,

- Pedagogy/Course delivery tools: Chalk and talk, Power point presentation
- Lab Component/ Practical topics: Toyota Engine lab
- Links https://www.youtube.com/watch?v=wAcv5_8amt82
  https://www.youtube.com/watch?v=YAdgv9R3G7w

Unit III

Power Trains: Principle of friction clutches and constructional details, Single plate, multi-plate and centrifugal clutches.

Gear box: Necessity for gear ratios in transmission, synchromesh gear box. Freewheeling mechanism, planetary gears systems, over drives, fluid coupling and torque converters, Epi-cyclic gear box, principles of automatic transmission.

Drive to wheels. Propeller shaft and universal joints, Hotchkiss and torque tube drives, differential, rear axle, steering geometry, camber, king pin inclination, included angle, castor, toe in & toe out, condition for exact steering, steering gears, hydraulic and electric power assisted power steering.

- Pedagogy/Course delivery tools: Chalk and talk, Power point presentation
- Lab component/ Practical topics: IC engine lab and Toyota engine lab
- Links https://www.youtube.com/watch?v=0UhDnbsTuU8
  https://www.youtube.com/watch?v=AAJyUk4wHfI

Unit IV

Automotive Chassis & Suspension system: Types of chassis layout with reference to power plant locations and drive, Vehicle frames. Various types of frames. Constructional details, Materials, Loads acting on vehicle frame.

Suspension system: Requirements of suspension system, torsion bar suspension systems, leaf spring, coil spring, dependent and independent suspension system, Air suspension system.

Brakes: Types of brakes, mechanical, air, hydraulic braking systems, Disk brakes, drum brakes, Antilock –Braking systems.

- Pedagogy/Course delivery tools: Chalk and talk, Power point presentation
- Lab component/ Practical topics: Toyota engine lab
- Links https://www.youtube.com/watch?v=I52d5CvE5s4
  https://www.youtube.com/watch?v=GinzMttVE1M

Unit V

Automotive emission control systems: Automotive emission controls, controlling crankcase emissions, controlling evaporative emissions, Cleaning the exhaust gas, Controlling the air-fuel mixture, Controlling the combustion process, Exhaust gas recirculation, Treating the exhaust gas, Catalytic converter, Emission standards- Euro I, II, III and IV norms, Bharat Stage II, III norms.

Boosting system for IC engine: Superchargers, Turbochargers, Turbocharger lag.

- Pedagogy/Course delivery tools: Chalk and talk, Power point presentation
- Lab component/ Practical topics: IC engine lab
- Links https://www.youtube.com/watch?v=V83pI7WbSpM
  https://www.youtube.com/watch?v=ziZ5Bth4vlk

Text Books:

1. Automotive Mechanics, William H Crouse & Donald L Anglin, 10th Edition Tata McGraw Hill Publishing Company Ltd., 2007.
2. Automobile engineering, Kirpal Singh. Vol I and II.
3. Automotive Mechanics by S. Srinivasan, Tata McGraw Hill.

Reference Books:

1. Internal Combustion Engines, V. Ganesan, McGraw Hill Publication, 4th Edition.
2. Automotive mechanics: Principles and Practices, Joseph Heitner, D Van Nostrand Company, Inc.
3. Automobile Engineering, R.B. Gupta, Satya Prakashan.
4. Mechatronics Principles & Applications, by Godfrey Onwubolu, 2006.

Course Learning Outcomes (COs):

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

1. Identify different components of an IC engine and operating principle of SI & CI engines. (PO1, 3).
2. Demonstrate the basic knowledge in IC engine power train. (PO1, 2, 3).
3. Interpret the need of chassis, suspension, brake and steering system in an automotive vehicle. (PO1, 6).
4. Exhibit the skills on emission standards (PO6, 7, 8).
5. Defend the application of boosting elements for an IC engine (PO1, 3).

Course Assessment and Evaluation:

Continuous Internal Evaluation (CIE): 50 Marks		
Assessment tool	**Marks**	**Course outcomes addressed**
Internal test-I	30	CO1 & CO2
Internal test-II	30	CO3, CO4 & CO5
Average of the two internal tests will be considered for evaluation of 30 Marks		
Other components- 20 Marks		
Assignment	10	CO1, CO2 & CO3
Quiz	10	CO4 & CO5
Semester End Examination (SEE): 100 Marks		
Semester End Examination	100	CO1, CO2, CO3, CO4 &CO5

ADDITIVE MANUFACTURING	
Course Code: MEOE 11	**Credits: 3:0:0**
Pre – requisites: Nil	**Contact Hours: 45L+45S**
Course Coordinator: Dr. Jayachristian K G	

Unit I

Additive Manufacturing, AM Information work flow, AM – An Integral part of Time compression Engineering, Classification of AM processes (As per ASTM F42), The Benefits of AM, Distinction Between AM and CNC Machining.

Vat Photo Polymerization Processes: Introduction, Photo polymerization Process (SLA),Extrusion-Based Systems: Introduction, Basic Principles, Fused Deposition Modeling process, Materials, Limitations of FDM.

- Pedagogy/Course delivery tools: Chalk and talk, Power point presentation
- Links https://www.youtube.com/watch?v=ICjQ0UzE2Ao
https://www.youtube.com/watch?v=7jNodHYUQc8

Unit II

Software Issues for Additive Manufacturing: Preparation of CAD Models, Scanning and digitization – the STL File, Problems with STL Files, STL File Manipulation, Beyond the STL File.Solid Ground curing: Introduction, Basic Principles, SGC Process, Materials. LOM, Binder Jetting process, Benefits and Drawbacks, Applications.

- Pedagogy/Course delivery tools: Chalk and talk, Power Point presentation
- Links https://www.youtube.com/watch?v=ICjQ0UzE2Ao.

Unit III

Design for Additive Manufacturing: Design for Manufacturing and Assembly, Introduction to Design for Additive Manufacturing, General Guidelines for Designing AM Parts, Design to Minimize Print Time, Design to Minimize Post-processing.

Post-processing: Support Material Removal, Polymer Surface Treatments: Vapour Smoothing,Sand Blasting, Tumbling, Metal Surface Treatments: Shot-Peening, Machining and Grinding, Anodizing, Plasma Spraying, Plating and PVD.

- Pedagogy/Course delivery tools: Chalk and talk, Power point presentation
- Links https://www.youtube.com/watch?v=U0xxd70g0y0
https://www.youtube.com/watch?v=uuCt_8nGDrM

Unit IV

Powder Bed Fusion: Selective Laser Sintering: Introduction, Process parameter, SLS sintering process, Electron Beam melting (EBM) process.

Directed Energy Deposition Processes: Introduction, General DED Process Description, Material Delivery, DED Systems, Process Parameters, DED Benefits and Drawbacks.

- Pedagogy/Course delivery tools: Chalk and talk, Power point presentation
- Links https://youtu.be/LjWL-lQe6ok

Unit V

Indirect Methods for Rapid Tool Production, Role of Indirect Methods in Tool Production, Metal Deposition Tools, RTV Tools, Epoxy Tools, Direct Methods for Rapid Tool Production: Classification of Direct Rapid Tool Methods, RapidTool process, Sand Form, Pattern for Investment and Vacuum Casting, Functional Models.

- Pedagogy/Course delivery tools: Chalk and talk, Power point presentation

Text Books:

1. Additive Manufacturing Technologies, I. Gibson l D. W. Rosen l B. Stucker, Springer New York Heidelberg Dordrecht London, 2010.
2. Stereo lithography and other RP &MTechnologies, Paul F.Jacobs: "SME, NY 1996. 3. Rapid manufacturing, Fiham D.T & Dinjoy S.S Verlog London 2001.
4. Rapid Prototyping: Principles and Application, by Rafiq I. Noorani

Course Outcomes

CO1: Explain the fundamentals, workflow, classifications and process parameters of additive manufacturing processes. (PO1,2,4,11, PSO1,2)

CO2: Apply CAD modelling, STL file preparation and software tools for additive manufacturing. (PO1,2,3,4,5,11, PSO1,2)

CO3: Analyze Design for Additive Manufacturing principles and post-processing techniques. (PO1,2,3,4,5,11, PSO1,2)

CO4: Compare SLS, EBM and DED metal additive manufacturing processes. (PO1,2,3,4,5,11, PSO1,2)

CO5: Evaluate rapid tooling methods and select suitable AM techniques for engineering applications. (PO1,2,3,4,5,11, PSO1,2)

Course Assessment and Evaluation:

Continuous Internal Evaluation (CIE): 50 Marks		
Assessment tool	**Marks**	**Course outcomes addressed**
Internal test-I	30	CO1 & CO2
Internal test-II	30	CO3, CO4 & CO5
Average of the two internal tests will be considered for evaluation of 30 Marks		
Other components- 20 Marks		
Assignment	10	CO1, CO2 & CO3
Quiz	10	CO4 & CO5
Semester End Examination (SEE): 100 Marks		
Semester End Examination	10	CO1, CO2, CO3, CO4 &CO5

GEOMETRIC DIMENSIONING AND TOLERANCING FOR MECHANICAL DESIGN	
Course code: MEAEC 59	**Credits: 1:0:0**
Pre-requisites: Nil	**Contact Hours: 15L+15S**
Course Coordinator: Dr. Mohandas K N	

Course Content

UNIT – I

Introduction to GD&T: Understand the importance and need for GD&T in engineering design and manufacturing, Definition and purpose of GD&T, Advantages of GD&T over traditional dimensioning.

Basic Terminology in GD&T: Fundamental GD&T terms and symbols, Geometric features and their definition, Types of tolerances: form, orientation, location, and run-out, Termino logy of features of size, datum, and datum features, Introduction to the GD&T symbol set.

Symbols, Terms, and Rules: Geometric characteristic symbol, the datum feature symbol, other symbols used with geometric tolerancing, rules.

- Pedagogy/Course delivery tools: Chalk and talk, PowerPoint presentation
- Links: https://www.youtube.com/watch?v=G7wnGeR_69k
- Links: https://www.youtube.com/watch?v=zjlJ9gA5W1Q
- Links: https://www.youtube.com/watch?v=JGiJLR-rTD4

UNIT – II

Datums and Datum Features: Learn the significance and application of datums in GD&T, Concept of datum and datum features

Tolerances of Form: Fundamentals of the tolerances related to the shape of features, Straightness, Flatness, Circularity (Roundness), Cylindricity.

Tolerances of Orientation: Parallelism, Perpendicularity, Angularity concepts.

- Pedagogy/Course delivery tools: Chalk and talk, PowerPoint presentation
- Links: https://www.youtube.com/watch?v=MxvJ9aWbiY8
- Links: https://www.youtube.com/watch?v=hdpGPFLovhE
- Links: https://www.youtube.com/watch?v=QLNYYWicWvA

UNIT – III

Tolerances of Position: Basics, Applications and needs

Tolerances of Location: Introduction, purpose, applications.

- Pedagogy/Course delivery tools: Chalk and talk, PowerPoint presentation
- Links: https://www.youtube.com/watch?v=XbTbYxdrRYg
- Links: https://www.youtube.com/watch?v=UOaTdaXMCmg

UNIT – IV

Position – Coaxiality: Definition and applications.

Run-out Tolerance: Definition, Circular Run-out, Total Run-out, specifying run-out.

Tolerances of Profile: Definition and importance in mechanical engineering, Applications.

- Pedagogy/Course delivery tools: Chalk and talk, PowerPoint presentation
- Links: https://www.youtube.com/watch?v=mUjQhWE0IFA
- Links: https://www.youtube.com/watch?v=kiV-da6cli8
- Links: https://www.youtube.com/watch?v=PLnMkcYywVA

UNIT – V

Concentricity: Definition, specifying concentricity, application of concentricity.
Tolerance stack –up: Fundamentals, General steps for 1-D stack up

- Pedagogy/Course delivery tools: Chalk and talk, PowerPoint presentation
- Links: https://www.youtube.com/watch?v=PcDaJBzSK90
- Links: https://www.youtube.com/watch?v=3pi7tra6by8
- Links: https://www.youtube.com/watch?v=rjLikea205w

Course Outcomes:

- **CO1:** Apply the knowledge of GD&T to ensure precision in manufacturing and quality control processes. (PO1, PO3, PSO1, PSO2)
- **CO2:** Be able to apply GD&T in the design and manufacturing of mechanical component. (PO1, PO2, PO3, PSO1, PSO2)
- **CO3:** Accurately interpret and annotate engineering drawings using GD&T symbols. (PO1, PO3, PO10, PSO1, PSO2)
- **CO4:** Competence in Using GD&T for Manufacturing and Quality Control. (PO1, PO3, PSO1, PSO2)
- **CO5:** Ability to Perform to graphic Analysis. (PO1, PO2, PSO1, PSO2)

Textbook:

1. "Geometric Dimensioning and Tolerancing for Mechanical Design" Gene R Cogorno, 3rd Edition, Mc.Graw Hill Publication, 2020.

Reference Book:

1. “Mechanical Tolerance Stackup and Analysis” Bryan R Fischer, 2nd Edition, CRC Press, 2011.
2. "Geometric Dimensioning and Tolerancing" James D. Meadows, Industrial Press, Inc., 2017.
3. "Fundamentals of Geometric Dimensioning and Tolerancing" Alexander L. D. S. Beiter, CRC Press, 2017.

Course Assessment and Evaluation:

Continuous Internal Evaluation (CIE): 50 Marks		
Assessment tool	**Marks**	**Course outcomes addressed**
Internal test-I	30	CO1 & CO2
Internal test-II	30	CO3, CO4 & CO5
Average of the two internal tests will be considered for evaluation of 30 Marks		
Other components- 20 Marks		
Assignment	10	CO1, CO2, CO3, CO4 & CO5
Quiz	10	CO1, CO2, CO3, CO4 & CO5
Semester End Examination (SEE): 100 Marks		
Semester End Examination	100	CO1, CO2, CO3, CO4 & CO5

TECHNICAL SKILL ENHANCEMENT COURSE	
Course code: ME68	**Credits: 0:1:0**
Pre-requisites: Nil	**Contact Hours: 30T**
Course Coordinator: Dr. Lokesha K, Dr.Sunith Babu	

Course Content

UNIT – I

Product Design: Overview of product design, design thinking, innovation process, stages of product development, market research, needs analysis, concept generation, selection, functional analysis, selection of materials, manufacturing constraints, human factors, form and color, life cycle analysis, environmental impact, ethics, engineering drawings, technical reports, presentation.

Pedagogy/Course delivery tools: Chalk and talk, PowerPoint presentation

- Links: https://youtu.be/9WPZStQp03Q?si=2IPDyllA4ngJjbrV
- Links: https://youtu.be/d5WcD3dw_Dc?si=cPNyo6FGe2wvZ3L2
- Links: https://youtu.be/3JmRRrILDc8?si=zWna7umpHC0xB940

UNIT – II

CAD/CAM and Kinematics of Machines: Introduction to CAD, geometric modeling, CAD software interfaces, wireframe, surface, and solid modeling, robotics, FMS, AI in CAD/CAM, Industry 4.0 concepts. **Kinematics of Machines:**Definitions (link, joint, kinematic pair/chain), degrees of freedom, Grashoff's criterion, inversions of mechanisms, quick-return, straight line, steering, and intermittent motion mechanisms.

Pedagogy/Course delivery tools: Chalk and talk, PowerPoint presentation

- Links: https://youtu.be/0IgOapAtauM?si=_4MoMsiW_cbf_YW-
- Links: https://www.youtube.com/live/3uKZfqRrIj8?si=az0nY9o2pqep838i
- Links: https://youtu.be/cAV90YRjC5w?si=gqyPQxLThm0Lnach

UNIT – III

Electric Vehicle Technology: History of EVs, EV vs ICE, hybrid systems, EV architecture, Electric motors, drives, inverters, converters, regenerative braking, Battery types (Li-ion, etc.), charging/discharging, battery management, Basic electronics, microcontrollers, control logic, Charging types, protocols, smart charging, Policy, emission standards, ADAS, global trends.

Pedagogy/Course delivery tools: Chalk and talk, PowerPoint presentation

- Links: https://youtu.be/A3fHQsIkYeU?si=ozqownNUHuBO9yGu
- Links: https://youtu.be/D-Me6n2CqE8?si=-ay8A6smO9rQPJQk

UNIT – IV

AI for Mechanical Engineers: Introduction, history and types of AI, impact on industry **,**
AI in manufacturing- Predictive maintenance, process optimization, quality control, Path planning, control, ML for robotics, Data-driven modeling, AI for FEA, CFD, design.

Pedagogy/Course delivery tools: Chalk and talk, PowerPoint presentation

- Links: https://youtu.be/1yWHwH5asK8?si=3pQpCXmEb62NjPMf
- Links: https://youtu.be/yADlxGz6nGE?si=82lybrF9wHnkZYo2

UNIT – V

Cooling systems in Engineering: Definition and scope of cooling systems, Applications in engineering, industry, and daily life, Refrigeration, air conditioning, types and classification of refrigerants, Cryogenic cooling: applications, insulation, storageandhandlingofcryogenicfluids, Newandhybridsystemtrends.

Pedagogy/Course delivery tools: Chalk and talk, PowerPoint presentation

- Links: https://youtu.be/4gGMBNEzeuc?si=MWD8Q-i-syRF79dr
- Links: https://youtu.be/fcRR95Sy8_U?si=JdAAmLAUkfVdH4ke

Course Outcomes:

CO1: Understand the stages of the product design process, from ideation to prototyping and Validation. (PO1, PO2, PO3, PSO1)

CO2: Demonstrate proficiency in using industry-standard CAD and CAM software for component and assembly modelling. (PO1, PO5, PSO1)

CO3: Explain the architecture, major components, and working principles of electric and hybrid electric vehicles**.** (PO1, PO3)

CO4: Describe foundational AI and machine learning concepts relevant to mechanical engineering applications**.** (PO1, PO5)

CO5: Explain the fundamental principles and types of cooling systems used in refrigeration, air conditioning, and industrial applications. (PO1, PSO1)

Course Assessment and Evaluation:

Continuous Internal Evaluation (CIE): 50 Marks		
Assessment tool	**Marks**	**Course outcomes addressed**
Internal test-I	30	CO1 & CO2
Internal test-II	30	CO3, CO4 & CO5
Average of the two internal tests will be considered for evaluation of 30 Marks		
Other components- 20 Marks		
Assignment	10	CO1, CO2, CO3, CO4 & CO5
Quiz/Assignment/Surprise test	10	CO1, CO2, CO3, CO4 & CO5

ENVIRONMENTAL STUDIES	
Subject Code: HS510	**Credits: 0:0:0**
Pre requisites: Nil	**Contact Hours: 15L**
Course Coordinator: Niranjan G H	

Course Content

Unit I

Environment, Ecology and Biodiversity: Definition, scope and importance. Multidisciplinary nature of Environmental studies. Food chain and food web. Energy flow and material cycling in ecosystem. Biodiversity and threats to biodiversity. Concept of sustainable development: Definition, objectives and applications.

- Pedagogy/Course delivery tools: Chalk and Talk, Power point presentations, Videos, Models
- Link: https://youtu.be/I_bnGkviWOUhttps://youtu.be/Ar04qG1P8Es

Unit II

Natural resources:

Forest resources: Ecological importance of forests. Water resources: Global water resources distribution. Mineral resources: Environmental effects of extracting and processing Mineral resources. Food resources: Effects of modern agriculture. Land resources: Soil erosion and Desertification.

- Pedagogy/Course delivery tools: Chalk and Talk, Power point presentations, Videos
- Link: https://youtu.be/vsXv3anIBSUhttps://youtu.be/1rOVPqaUyv8

Unit III

Energy Sources: Growing energy needs. Conventional and non-conventional / Renewable and Non-renewable energy sources. Bio Energy-Ethanol and Bio mass energy. Energy of the future – Hydrogen fuel cells and Nuclear energy. Environmental Impact Assessment (EIA): Definition, Objectives and benefits. Step by step procedure of conducting EIA.

- Pedagogy/Course delivery tools: Chalk and Talk, Power point presentations, Animations, Models
- Link: https://youtu.be/mh51mAUexK4https://youtu.be/XS-eXqppf_w

Unit IV

Environmental Pollution: Definition, Causes, Effects and control measures of Water pollution, Air pollution and Soil/ land pollution. Management of Municipal Solid Waste and treatment methods of municipal solid waste.

- Pedagogy/Course delivery tools: Chalk and Talk, Power point presentations, Videos
- Link: https://youtu.be/NRoFvz8Ugeo, https://youtu.be/DAQapF-F4Vw

Unit V

Environmental protection: Global warming and Climate change, Acid rain, Ozone layer depletion. Salient features of Environmental Protection Act, Air & Water Acts. Functions of Central and State Pollution Control Boards.

- Pedagogy/Course delivery tools: Chalk and Talk, Power point presentations, Open source softwares
- Link: https://youtu.be/iV-BvYwl4Y8 , https://youtu.be/BYqLRGawoH0

Text Books:

1. **S M Prakash** – Environmental Studies, Elite Publishers, 2007.
2. **Benny Joseph-** Environmental studies, Tata Mcgraw-Hill 2nd edition 2012.
3. **R Geetha Balakrishna & K G Lakasminarayana Bhatta**- Environmental Studies, S M Publications, 2006-2007.

Reference Books:

1. **P. Venugopala Rao** – Principles of Environmental Science & Engineering Prentice Hall of India, 1st edition, 2006.
2. **N Balasubramanya & Gurdeep R Chatwal-** Himalaya publishing House, 2007.
3. **Dr. B.S Chauhan-** Environmental studies, university of science press 1st edition

Web links and video Lectures (e- Resources):

1. https://youtu.be/I_bnGkviWOU
2. https://youtu.be/vsXv3anIBSU
3. https://youtu.be/mh51mAUexK4
4. https://youtu.be/NRoFvz8Ugeo
5. https://youtu.be/iV-BvYwl4Y8

Course Outcomes (COs):

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

1. Describe the importance of environmental studies, sustainable development and biodiversity (PO-1, 7)
2. Explain the importance and conservation of impacts of natural resources (PO-1, 7)
3. Distinguish the energy sources and identify the alternative energy sources for sustainable development (PO-1, 7)
4. Identify the causes, effects and control measures of pollution in developmental activities (PO-1, 7)
5. Outline the current environmental issues and the role of the agencies for environmental protection (PO-1, 7)

Course Assessment and Evaluation:

Continuous Internal Evaluation (CIE): 50 Marks		
Assessment tool	**Marks**	**Course outcomes attained**
Internal Test-I	30	CO1, CO2 & CO3
Internal Test-II	30	CO4 & CO5
Average of the two internal test shall be taken for 30 marks		
Other components		
Assignment – MCQ, Models	10	CO1, CO2, CO3, CO4 & CO5
Assignment – Quiz, Group Presentation	10	CO1, CO2, CO3, CO4 & CO5
Semester End Examination (SEE)	50	CO1, CO2, CO3, CO4 & CO5