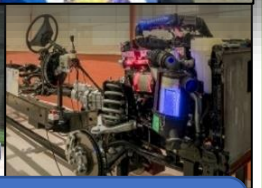
III - VIII Semester Scheme & Syllabus (2021) Department of MECHANICAL ENGINEERING

SCHEME AND SYLLABUS



Department of

MECHANICAL ENGINEERING

GLOBAL ACADEMY OF TECHNOLOGY

(Autonomous institution affiliated to VTU, Belagavi.
Accredited by NAAC with 'A' grade,
NBA Accredited CS, E&C, E&E, MECH and IS branches)

IDEAL HOMES TOWNSHIP,
RAJA RAJESHWARI NAGAR,
BENGALURU - 560098

Head of Department
Mechanical Engineering
Global Academy of Technology
Bangalore - 98

Global Academy of Technology – An Overview

(Autonomous Institution under Visvesvaraya Technological University, Belagavi)

Vision of the Institute:

Become a premier institution imparting quality education in engineering and management to meet the changing needs of society.

Mission of the Institute:

- **Create environment conducive for continuous learning through quality teaching and learning processes supported by modern infrastructure.**
- **Promote Research and Innovation through collaboration with industries.**
- **Inculcate ethical values and environmental consciousness through holistic education programs.**

Objectives:

With a very firm resolve, Global Academy of Technology is continuously investing untiring efforts to enable students to:

- Develop careers in Government and Private engineering organizations and other professionally related domains.
- Pursue higher studies and research to develop innovative solutions and technologies in engineering and other multi-disciplinary areas.
- Improve professional and personal traits oriented towards professional ethics and environmental compulsions.
- Inculcate professional leadership and successful entrepreneurship qualities.
- Help society in raising the quality of life.

Quality Policies:

a. Providing Excellent Education Through High Quality, Experienced and Committed Faculty.
b. Evolving creative processes for optimal Knowledge and Skill Transfer.
c. Building up state-of-the-art infrastructure at par with international standards.
d. Creating an environment for holistic personality development and develop research temperament.

HALLMARKS OF GLOBAL ACADEMY OF TECHNOLOGY:

- Proactive management determined to build the institute as a Centre of Excellence in engineering education.
- Qualified and dedicated faculty in all the departments.
- State of the art Infrastructure and up to date laboratory and Library facilities.
- Lush green campus with an environment of tranquillity and harmony.
- Student centric teaching-learning processes banking on Outcome Based Education; students friendly learning atmosphere.
- Emphasis on Project based learning throughout the course.

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- Strong Industry-Institute interface with more than twenty Memorandum of Understanding (MOUs) signed with leading industries and institutions of repute.
- Indian Institute of Information Technology (IIIT), Allahabad, has signed a MOU for providing internships to students of GAT, research assistance to faculty, and conducting Faculty Development Programs in key areas of IT - Big Data, Cloud Computing, Artificial Intelligence, and Machine Learning.
- Mahatma Gandhi University, Kottayam, has signed a MOU to facilitate research in Nano Technology and provide research assistance to faculty of GAT.
- Industrial consultancy undertaken in many departments.
- Excellent Placement with more than 80% of the eligible students placed in leading IT companies, core industries and Start-up companies.
- Holistic and integrated training modules covering communication skills, leadership skills, soft skills and technical skills through professional trainers.
- On campus and off campus internship facilities.
- Robust parent connects and Student counselling system.
- In-house technical skill training programs/add on courses to enhance the employability of the students.
- Strong and growing alumni connect in place.
- Exclusive Research and Development, Industry–Institute Interaction Cell and Teaching and Learning Centre in place.
- Rainwater harvesting facility in the campus.

The following academic processes are implemented on a regular basis to sustain a meaningful and proactive teaching-learning environment:

- Emphasis on **continuous revision of the curriculum,** based on feedback from the students and input from industry, alumni, and other stakeholders.
- Conduction of regular **training programme** for faculty, technical & supporting staff.
- Conduction of Academic Audit of each department on an annual basis.
- Under **open electives** students have the options to study subjects offered by other departments to augment their interdisciplinary knowledge.
- Students have to do **value added courses**, mandatory courses, certificate courses, and become members of professional bodies, etc.
- Advanced and enrichment courses are offered as Electives during the final year UG and PG Degree Programmes.
- **Self-Learning** is encouraged in students through MOOCs, NPTEL/SWAYAM, Coursera, Edex etc. Credit shall be awarded to students for completion of such courses.

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Department of Mechanical Engineering

(Accredited by National Board of Accreditation, New Delhi)

Vision of the Department:

Become one of the leading providers of education in mechanical engineering with emphasis on research, development, and innovation for the benefit of society.

Mission of the Department:

- Impart quality technical education in the field of mechanical engineering through excellent teaching-learning process, modern infrastructure and computing tools
- Prepare students for successful careers by providing placements and encouraging research, development and innovation through industry-institute interaction
- Instil professional ethics and environmental consciousness amongst students through inclusive development programs

About the Department:

Mechanical Engineering is one of the broadest and the most versatile engineering profession finding its application in all fields of technology. The boost in the manufacturing sector has raised the demand for Mechanical Engineers exponentially. The uniqueness of the discipline incorporates skills and expertise in the areas of Design, Manufacturing, Mechanics and Thermal sciences besides inter-disciplinary subjects that are essential to most sectors of industry.

The department is achieving its milestones at various stages of its growth by upgrading the course-curriculum for catering the needs of industry and research, by developing and maintaining state-of-art laboratories CNC Technology, 3D Printing and Automation.

The department conducts various training programs in collaboration with renowned industrial organizations such as Toyota, AMS-India, TATA Electronics Pvt. Ltd, EMI Product, Askar Microns, etc.

Our student teams have developed Formula Car, Go Kart and Solar Powered Vehicle and participated in racing competitions, won prizes, and have brought laurels to our department and to the college.

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III - IV SEMESTER
SCHEME AND SYLLABUS
Department of
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(Autonomous Institution Affiliated to VTU)
Scheme of UG Autonomous Program – 2021 Batch

III SEMESTER

Sl. No.	Course Code	Course Title	Course Type	Teaching Dept.	Teaching Hours/Week			Examination			CREDITS
					L	T	P	CIE	SEE	Total	
1	21MAT31C	Complex Variables & Probability	BS	MAT	2	2	0	50	50	100	3
2	21MED32	Strength of Materials (integrated)	IPC	Respective Department	3	0	2	50	50	100	4
3	21MED33	Manufacturing Process (Integrated)	IPC		3	0	2	50	50	100	4
4	21MED34	Thermodynamics	PC		2	2	0	50	50	100	3
5	21MED35	Material Science and Metallurgy	PC		3	0	0	50	50	100	3
7	21KSK36/46	Samskrutika Kannada	HSM	Any Department	1	0	0	50	50	100	1
	21KBK36/46	Balake Kannada									
	OR										
	21CPH36/46	Constitution of India and Professional Ethics									
8	21MED37	Ability Enhancement Course – I : **Modelling & 3D Printing**	PC	Respective Department	0	0	2	50	50	100	1
							Total	**350**	**350**	**700**	**19**
9	21MATDIP31	Additional Mathematics (For Lateral Entry Students)	BS	MAT	2	2	0	100	--	100	0

IV SEMESTER

Sl. No.	Course Code	Course Title	Course Type	Teaching Dept.	Teaching Hours/Week			Examination			CREDITS
					L	T	P	CIE	SEE	Total	
1	21MAT41C	Transforms Calculus and Numerical Techniques	BS	MAT	2	2	0	50	50	100	3
2	21MED42	Mechanical Measurements & Metrology (Integrated)	IPC	Respective Department	3	0	2	50	50	100	4
3	21MED43	Mechatronics	PC		3	0	0	50	50	100	3
4	21MED44	Theory of Machines	PC		2	2	0	50	50	100	3
5	21MED45	Computer Aided Modelling	PC		2	2	0	50	50	100	3
7	21KSK36/46	Samskrutika Kannada	HSM	Any Department	1	0	0	50	50	100	1
	21KBK36/46	Balake Kannada									
	OR										
	21CPH36/46	Constitution of India and Professional Ethics									
8	21MED47	Ability Enhancement Course – II: Automotive Engines, GD&T.	PC	Respective Department	0	0	2	50	50	100	1
9	21INT48	Inter/Intra Institutional Internship	INT	Respective Department	0	0	3	100	-	100	2
10	21MEDL49	Machine Shop	PC	Respective Department	0	0	1	50	50	100	1
							Total	**450**	**350**	**800**	**21**

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III SEMESTER

SYLLABUS

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SEMESTER – III

Course: Complex Variables and Probability (Common for ME/AE)

Course Code	**21MAT31C**	**CIE Marks**	**50**
Hours/Week (L: T: P)	**2 : 2 : 0**	**SEE Marks**	**50**
No. of Credits	**3**	**Examination Hours**	**03**

Course Objectives: To enable students to apply the knowledge of mathematics in the field of engineering by making them to learn:

CLO1	Analytic functions and complex line integrals
CLO2	Probability distributions
CLO3	Joint probability distributions
CLO4	Sampling distributions and testing of hypothesis

	No. of Hours / RBT levels
Module 1 Function of a complex variable, Analytic functions, Cauchy-Riemann equations, construction of analytic functions using Milne Thomson method, Properties of analytic functions.	**08 Hours L2, L3**
Module 2 Conformal mapping, Bilinear transformations. Complex line integrals, Cauchy's theorem, Cauchy's integral formula, Singularities, poles, residues, Cauchy's residue theorem.	**08 Hours L2, L3**
Module 3 Probability, Axioms of probability, Conditional probability, Bayes theorem, Discrete and continuous random variables, Moments, Moment generating functions, Binomial, Uniform, Exponential, Poisson, Normal distributions.	**08 Hours L2, L3**
Module 4 Joint distributions, Marginal and conditional distributions, Expectation and Covariance. Transformation of random variables, Central limit theorem and law of large numbers.	**08 Hours L2, L3**
Module 5 Sampling, Sampling distributions, standard error, test of hypothesis for means and proportions, student's t-distribution, chi-square distribution as a test of goodness of fit.	**08 Hours L2, L3**

COURSE OUTCOMES: Upon completion of this course, student will be able to:

CO31.1	Apply Cauchy Riemann equations to study different properties of analytic functions
CO31.2	Evaluate complex line integrals
CO31.3	Solve problems associated with random variables using probability distributions
CO31.4	Solve problems related to testing of hypothesis

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Textbooks:

1. B. S. Grewal, Higher Engineering Mathematics, Khanna Publishers 44th Edition, 2017
2. T Veerarajan, Probability, Statistics and Random Processes for Engineers, Tata McGraw Hill, 3rd Edition, 2008

Reference books:

1. B.V. Ramana, Higher Engineering Mathematics, Tata McGraw-Hill, 2006
2. N.P.Bali and Manish Goyal, A Textbook of Engineering Mathematics, Laxmi Publications 6 th Edition, 2014
3. Richard H Williams, Probability, Statistics and Random Processes for Engineers, Cengage Learning, 1st Edition, 2003.

Scheme of Examination:

Semester End Examination (SEE):
SEE Question paper is to be set for 100 marks and the marks scored will be proportionately reduced to 50. There will be two full questions (with a maximum of three sub questions) from each module carrying 20 marks each. Students are required to answer any **five full questions** choosing at least **one full question from each module.**

Continuous Internal Evaluation (CIE):
Three Tests are to be conducted for 40 marks each. Average of Marks scored in all three tests is added to test component. CIE is executed by way of quizzes / Alternate Assessment Tools (AATs), and three tests. **Some possible AATs:** seminar/assignments/ mini-projects/ concept videos/ partial reproduction of research work/ group activity/ any other.

Typical Evaluation pattern for regular courses is shown in Table 2.

Table 2: Distribution of weightage for CIE & SEE of Regular courses

Component		Marks	Total Marks
CIE	CIE Test-1	**40**	**50**
	CIE Test-2	**40**	
	CIE Test-3	**40**	
	Assignments	**10**	
SEE	Semester End Examination	**50**	**50**
Grand Total			**100**

CO/PO Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO31.1	3	2	1									3				
CO31.2	3	2	1									3				
CO31.3	3	2	1									3				
CO31.4	3	2	1									3				
Average	3	2	1									3				

Low -1: Medium-2: High-3

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SEMESTER – III
Course: STRENGTH OF MATERIALS (Integrated)

Course Code	**21MED32**	**CIE Marks (Theory + Lab)**	**30 + 20 = 50**
Hours/Week (L: T: P)	**3 : 2 : 0**	**SEE Marks**	**50**
No. of Credits	**4**	**Examination Hours**	**03**

Prerequisites: Engineering Mechanics

Course Objectives: This course will enable the students to:

CLO1	Identify different types of stresses and strains developed in the member subjected to axial, bending, shear, torsion & thermal loads.
CLO2	To Solve problems on Elastic constants and determine Principal stresses for Uniaxial and Biaxial loads.
CLO3	Concept of Shear Force and Bending Moment Diagrams for beams subjected to different types of loads.
CLO4	Determine the maximum bending and shear stress in a given beam.
CLO5	Apply torsion equation to calculate angle of twist, size of shafts & shear stresses

Content	No. of Hours/ RBT levels
Module 1 **Simple stresses and strains:** Introduction, Properties of materials, Stress, Strain, tensile & compressive stresses, shear stress, Elastic limit, Hooke's law, Stress strain diagram for brittle and ductile materials, True stress and strain, Bars of varying sections, Bars subjected to axial loads: Bars with uniform cross section, stepped bars, bars with continuously varying cross sections. (Circular & rectangular only) **Laboratory:** *Laboratory Exercise – 1, 2*	**08 Hours / L3**
Module 2 Thermal stresses, Shear stress and shear strain, Longitudinal strain, Lateral strain, Poisson's ratio, Volumetric strain, Elastic constants, and their relations. **Principal stresses and Mohr's Circle:** Introduction to uniaxial, bi-axial, bi-axial combined with shear stress, Stresses on inclined planes, Principal stresses and maximum shear stresses, Principal angles, Shear stresses on principal planes, Maximum shear tress, Mohr circle for plane stress conditions. **Laboratory:** *Laboratory Exercise – 3*	**08 Hours / L3**
Module 3 **Shear Force & Bending moment diagram:** Introduction, types of beams, loads & reactions, shear force & bending moment. Sign convention for shear force and bending moment, Shear force and bending moment diagram for simply supported, cantilever & overhanging beams subjected to concentrated loads, uniformly distributed load, uniformly varying load & external moment. Maximum bending moment & point of contra flexure. **Laboratory:** *Laboratory Exercise – 4*	**08 Hours / L3**

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Module 4 **Bending stress in beams:** Introduction, theory of Pure or Simple bending, assumptions in pure bending, bending equation, Bending stress, Section modulus for various cross sections and simple numerical. **Shear stresses in beams:** Introduction to shear stress, shear stress in beam, Shear stress distribution for rectangular and circular cross section, simple numerical on shear stress on I and T sections. **Laboratory:** *Laboratory Exercise – 4, 6*	**08 Hours / L3**
Module 5 **Torsion of circular shafts:** Introduction, pure torsion, assumptions, Derivation of shear stress produced in solid and hollow circular shafts subjected to torsion, polar moment of Inertia, polar section modulus, torsional rigidity, power transmitted by a shaft. Simple numericals. **Laboratory:** *Laboratory Exercise – 5, 7*	**08 Hours / L3**

COURSE OUTCOMES: Upon completion of this course, student will be able to:

CO32.1	Find the forces, simple stresses and strains for a structural problem.
CO32.2	Solve problems on thermal stresses, elastic constants and biaxial stresses combined with shear stress.
CO32.3	Solve problems on statically determinate beams and plot SFD and BMD subjected to different loads.
CO32.4	Find bending and shear stresses for statically determinate beams of different cross sections.
CO32.5	Apply the concepts of torsion to solve and analyze shafts subjected to simple torsion.

Laboratory:

Exercise Number	Experiment	No. of Hours/ RBT Levels
1	Brinell, Rockwell and Vickers's hardness tests	**01 Hours/ L3**
2	Tensile and Compression tests of metallic members on UTM	**04 Hours/ L3**
3	Shear tests of metallic members on UTM	**02 Hours/ L3**
4	Bending test on metallic and non-metallic specimens on UTM	**01 Hours / L3**
5	Torsion test	**01 Hours / L3**
6	Izod and Charpy impact tests on MS Specimen. (Demo only)	**01 Hours / L3**
7	Wear characteristics. (Demo only)	

Textbooks:

1. **James M Gere, Barry J Goodno**, Mechanics of Materials, 9th Edition, Cengage, 2019.
2. **Timoshenko**, Strength of Materials, 3rd Edition, CBS Publishers, 2002.

Reference books:

1. **William A Nash and Merle C Potter**, Strength of Materials, Schaum's Outline Series, 5th Edition, TMH.
2. **R C Hibbeler**, Mechanics of Materials, 9th Edition, Pearson, 2019.
3. **Ferdinand P. Beer, E. Russell Johnston Jr., John T. DeWolf, David F. Mazurek, Sanjeev Sanghi**, Mechanics of Materials by 8th Edition, Special Indian Edition, 2020.
4. **S Ramamrutham & R Narayanana**, Strength of Materials, Dhanat Rai Publishing Company, 18th Edition, 2016.

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E-Books / Web References

1. **E - Books:** "Strength of Materials", (http://freeengineeringbooks.com/Civil/Strength-of-Material-Books.php)
2. https://ocw.tudelft.nl/courses/aerospace-mechanics-of-materials/mechanics-subjects/

MOOCs

1. NPTEL Course: "Strength of Materials" http:// https://nptel.ac.in/courses/112/107/112107146/#
2. NPTEL Course: "Strength of Materials" (https://onlinecourses.nptel.ac.in/)
3. MOOC Course: "Mechanics of Materials Courses", (https://www.coursera.org/courses?query=mechanics%20of%20materials)
4. Free Video Lectures: "Strength of Materials", (https://freevideolectures.com/course/96/)

Scheme of Examination: (Integrated courses)

Semester End Examination (SEE): SEE Question paper is to be set for 100 marks and the marks scored will be proportionately reduced to 50. There will be two full questions (with a maximum of four sub questions) from each module carrying 20 marks each. Students are required to answer any **five full questions** choosing at least **one full question from each module.**

Note: The laboratory assessment would be restricted to only the CIE evaluation.

Continuous Internal Evaluation (CIE): Three Tests are to be conducted for 40 marks each. The average of the three tests are taken for computation of CIE on a scale of 30, the CIE would also include laboratory evaluation for 20 marks. The laboratory marks of 20 would comprise of 10 marks for regular laboratory assessment to include lab record and observation. 10 marks would be exclusive for laboratory internal assessment test to be conducted at the end of the semester.

Typical Evaluation pattern for integrated courses is shown in the Table below

Table: Distribution of weightage for CIE & SEE of Integrated courses

	Component	Marks	Total Marks
CIE	CIE Test-1	**30**	**50**
	CIE Test-2	**30**	
	CIE Test-3	**30**	
	Laboratory	**20**	
SEE	Semester End Examination	**100**	**50**
		Grand Total	**100**

CO/PO Mapping															
CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO32.1	3	2	2			1	1		1	1		1	2		
CO32.2	3	2	2			1	1		1	1		1	2		
CO32.3	3	2	2			1	1		1	1		1	2		
CO32.4	3	2	2			1	1		1	1		1	2		
CO32.5	3	2	2			1	1		1	1		1	2		
Average	3	2	2			1	1		1	1		1	2		

Low - 1: Medium - 2: High - 3

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SEMESTER – III

Course: MANUFACTURING PROCESS (Integrated)

Course Code	**21MED33**	**CIE Marks (Theory + Lab)**	**30 + 20 = 50**
Hours/Week (L: T: P)	**3 : 0 : 2**	**SEE Marks**	**50**
No. of Credits	**4**	**Examination Hours**	**03**

Prerequisites: Elements of Mechanical Engineering

Course Objectives: This course will enable the students to,

CLO1	Understand the various manufacturing processes and their methods involved in metal casting and process of moulding sands.
CLO2	Understand metal joining process, identify defects in weld, and cast components.
CLO3	Acquire knowledge of the working principles and operations performed on lathe, drilling, shaping, milling and grinding machines.
CLO4	Acquire knowledge of the working principles and operations performed on milling and metal finishing process.
CLO5	Acquire knowledge on principles and types of metal forming with specific regard to industrial applications.

Content	**No. of Hours/ RBT levels**
Module 1 **Pattern & Pattern Making** Introduction to manufacturing, classification of manufacturing processes, introduction to foundry - Steps involved in casting, advantages, limitations, and applications of casting process. Pattern types, pattern materials, color coding and storing of patterns, allowances for pattern. **Moulding** Moulding sand composition, preparation, properties, Binders, Additives. Moulding methods: No bake mould, sweep mould, CO_2 mould, shell mould, investment mould. Introduction to Melting furnaces, Direct and Indirect Furnace, Electric Arc Furnace, Cupola furnace. **Demonstration:** *Properties of Moulding Sand - Sand Testing* **Laboratory:** *Laboratory Exercise – I, II*	**08 Hours / L3**
Module 2 **Welding Process:** Arc welding: Principle, Metal arc welding (MAW), Flux Shielded Metal Arc Welding (FSMAW), Inert Gas Welding (TIG & MIG) Submerged Arc Welding (SAW), Resistance welding principles, Seam welding, Butt welding, Spot welding and Projection welding.	**08 Hours / L3**

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Defects & Inspection: Sand Casting defects, welding defects- detection causes & remedy, Methods used for inspection of casting and welding. Visual, magnetic particle, fluorescent particle, ultrasonic. Radiography, eddy current, holography methods of inspection. **Laboratory:** *Laboratory Exercise – III and IV*	
Module 3 **Lathe:** Types of lathes, parts of engine lathe, lathe accessories: Centres, Chuck, Faceplate, Mandrel, Steady rest, follower rest, lathe dog, cutting speed, feed, and depth of cut. Machining time and power consumption. **Drilling:** Working principle, the nomenclature of twist drill, Classification, radial drilling machine. Machining time and power consumption. **Shaping Machine:** Working principle, constructional features.	**08 Hours / L3**
Module 4 **Milling:** Principle of milling, types of milling machines, Horizontal and Vertical milling machine with a sketch, milling machine speeds, and feeds, Milling cutters, Indexing: Simple, compound, differential indexing with simple numerical. Machining time and power consumption. **Metal Finishing Processes:** Introduction to grinding, Plain Cylindrical, Surface, Centreless grinding machines. Surface finish and surface roughness, Introduction to lapping, Honing, Polishing, Buffing.	**08 Hours / L3**
Module 5 **Metal Forming Process** Introduction to metal forming processes & classification of metal forming processes, Hot working and cold working of metals, Forging: Smith forging, drop forging & press forging, rolling of metals, Flat strip rolling, shape rolling operations. Principle of rod and wire drawing, Tube drawing, Principles of Extrusion, Hot and Cold extrusion. **Laboratory:** *Laboratory Exercise – V and VI*	**08 Hours / L3**

COURSE OUTCOMES: Upon completion of this course, student will be able to:

CO33.1	Develop mould cavity using patterns made of wood, metal and plastics considering pattern allowances.
CO33.2	Select the appropriate arc welding process for the given application and identify the defects encountered after casting and welding process.
CO33.3	Comprehend the functioning of the Lathe machine, drilling machine, and shaping machine.
CO33.4	Comprehend the functioning of milling and metal finishing operations.
CO33.5	Incorporate the operations of metal forming process for the real time applications.

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Laboratory:

Exercise Number	Experiment	No. of Hours/RBT Levels
I & II	Preparation of Green Sand Mould - Single Piece Pattern and Split Piece Pattern and Development of a Cast product.	04 Hours/ L3
III & IV	Preparation of Welding Joints (At least two)	02 Hours/ L3
V & VI	Preparation of Forged Models (At least two)	04 Hours/ L3

Textbooks:

1. **P. N. Rao,** Manufacturing Technology Foundry, Forming & Welding, Volume-I, McGraw Hill Education India, 4th Edition, 2019.
2. **O.P. Khanna,** Volume I and II, Dhanpat Rai Publications, 2017.

Reference books:

1. **Lindberg,** Processes and Materials of Manufacture, Prentice Hall India (p) Ltd
2. **Dr. P.C. Sharma,** A Textbook of Production Technology, S.Chand & Company PVT.LTD, 4th Edition, 2014.
3. **Amitabha Ghosh, Ashok Kumar Malik,** Manufacturing Science, Affiliated East-West Press Ltd, 1st Edition, 2015.
4. **Hajra Choudhary,** Workshop Technology, Media Promoters & Publishers, 13th Edition.
5. **Kalpakjian S., Schmid S.R,** Manufacturing Engineering & Technology, Pearson Edu Asia, 4th Edition.

E-Books / Web References

1. Metal casting- https://nptel.ac.in/courses/112107083/
2. Manufacturing process I - https://nptel.ac.in/courses/112107145/17
3. Manufacturing Process (video) - http://nptel.ac.in/courses/112107145/
4. Manufacturing Process- http://freevideolectures.com
5. Introduction to Casting- https://nptel.ac.in/courses/112107083/
6. Types of Furnaces- https://nptel.ac.in/courses/112107239/16
7. Introduction to Metal Forming - https://nptel.ac.in/courses/112107145/4
8. Plastic properties and Processing- https://nptel.ac.in/courses/112107086/13

MOOCs

1. https://nptel.ac.in/courses/112/104/112104301/
2. https://nptel.ac.in/courses/112/104/112104195/

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3. https://www.youtube.com/watch?v=jdFrBtHeJbs&list=PLtAjRFb9nXmzRwSuuYmUoIxIQOu5ccdM
4. https://nptel.ac.in/courses/112/104/112104204/
5. https://nptel.ac.in/courses/112/104/112104195/
6. E-learning: www.vtu.ac.in

Scheme of Examination: (Integrated courses)

Semester End Examination (SEE):

SEE Question paper is to be set for 100 marks and the marks scored will be proportionately reduced to 50. There will be two full questions (with a maximum of four sub questions) from each module carrying 20 marks each. Students are required to answer any **five full questions** choosing at least **one full question from each module.**

Note: The laboratory assessment would be restricted to only the CIE evaluation.

Continuous Internal Evaluation (CIE):

Three Tests are to be conducted for 40 marks each. The average of the three tests are taken for computation of CIE on a scale of 30, the CIE would also include laboratory evaluation for 20 marks. The laboratory marks of 20 would comprise of 10 marks for regular laboratory assessment to include lab record and observation. 10 marks would be exclusive for laboratory internal assessment test to be conducted at the end of the semester.

Typical Evaluation pattern for integrated courses is shown in the Table below

Table: Distribution of weightage for CIE & SEE of Integrated courses

	Component	Marks	Total Marks
CIE	CIE Test-1	**30**	**50**
	CIE Test-2	**30**	
	CIE Test-3	**30**	
	Laboratory	**20**	
SEE	Semester End Examination	**100**	**50**
		Grand Total	**100**

CO/PO Mapping															
CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO33.1	3	2	1						1	1		1			3
CO33.2	3	2	1						1	1		1			3
CO33.3	3	2	1						1	1		1			3
CO33.4	3	2	1						1	1		1			3
CO33.5	3	2	1						1	1		1			3
Average	3	2	1						1	1		1			3

Low - 1: Medium - 2: High - 3

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SEMESTER – III

Course: THERMODYNAMICS

Course Code	**21MED34**	**CIE Marks**	**50**
Hours/Week (L: T: P)	**2 : 2 : 0**	**SEE Marks**	**50**
No. of Credits	**3**	**Examination Hours**	**03**

Course Objectives: This course will enable the students to:

CLO1	Introduce the fundamental concepts, terms and terminologies involved in thermodynamics
CLO2	Identify and describe energy exchange processes (in terms of various forms of energy, heat, and work) in thermodynamic systems using basic laws
CLO3	Introduce the fundamental concepts of basic vapor power and refrigeration cycles
CLO4	Develop the ability to apply basic principles in a systematic way to analyze basic thermodynamic cycles.
CLO5	Compute the performance parameters and testing methods of IC engines.

Content	No. of Hours/ RBT levels
Module 1 **Introduction, Basic Concepts**: Thermodynamic system and control volume, Microscopic and macroscopic point of view, thermodynamic properties, state of a substance, process and cycle, Thermodynamic equilibrium, Concept of Continuum, Quasi-static process, The Zeroth Law of Thermodynamics, Temperature scales, simple numerical. **First law of Thermodynamics**: First law for a closed system undergoing a cycle and change of state, energy, PMM1, first law of thermodynamics for steady flow process, steady flow energy equation applied to nozzle, diffuser, boiler, turbine, compressor, pump, heat exchanger and throttling process, simple numerical.	**08 Hours / L1, L2, L3**
Module 2 **Second law of thermodynamics**: Limitations of first law of thermodynamics, Kelvin-Planck and Clausius statements and their equivalence, PMM2, causes of irreversibility, Carnot theorem, and simple numerical. **Entropy**: Clausius theorem, property of entropy, inequality of Clausius, entropy change in an irreversible process, principle of increase of entropy, entropy change for non-flow and flow Processes, simple numerical.	**08 Hours / L1, L2, L3**
Module 3 **Pure Substances:** Properties of pure substances, Water and steam – Constant temperature and constant pressure heating, Use of steam tables: Saturation tables, Superheated tables. **Vapor Power cycles**: Carnot vapor cycle, Rankine cycle, comparison of Carnot and Rankine cycle, calculation of cycle efficiencies, simple numerical	**08 Hours / L1, L2, L3**

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Refrigeration Cycles: Simple Vapor Compression Refrigeration (VCR) cycle on P-h and T-s diagrams, analysis of the simple cycle, factors affecting the performance of the cycle, Reversed Carnot cycle and its limitation, Bell-Coleman cycle, simple numerical.	
Module 4 **Air Standard Cycles:** Carnot, Otto, Diesel, Dual and Stirling cycles, P-V and T -s diagrams, description, efficiencies (no derivations) and mean effective pressures (no derivations). Comparison of Otto, Diesel, dual cycles, simple numerical, Simple Brayton cycle, open and closed cycle, gas turbine fuels, actual Brayton cycle, optimum pressure ratio for maximum thermal efficiency (no derivation), work ratio, simple numerical.	**08 Hours / L1, L2, L3**
Module 5 **Internal Combustion Engines**: Performance parameters-calculations and its measurements - Motoring method, Willian's line method, dynamometers-mechanical, electrical, and hydraulic, Air box method, Morse test, Valve timing diagram, heat balance sheet, engine performance curves, simple numerical.	**08 Hours / L1, L2, L3**

COURSE OUTCOMES: Upon completion of this course, student will be able to:

CO34.1	Describe the fundamental principles of thermodynamics and apply the laws of thermodynamics to estimate the performance parameters of thermal systems.
CO34.2	Apply laws of thermodynamics and the concept of entropy to solve engineering problems involving closed and open systems by making proper assumptions
CO34.3	Estimate the performance of basic vapour power cycles and Refrigeration systems using corresponding thermodynamic property tables and charts.
CO34.4	Analyze the thermodynamic cycles of various thermal systems.
CO34.5	Demonstrate the knowledge of the energy conversion and performance characteristics of internal combustion engines applied to real time applications.

Textbooks:

1. **P K Nag,** Basic and Applied Thermodynamics, Tata McGraw-Hill, 2nd Edition, 2017
2. **R K Rajput,** Thermal Engineering, Lakshmi Publication, 10th Edition, 2018.

Reference books:

1. **Yunus A Cengel, Michael A Boles,** Thermodynamics-An Engineering Approach, McGrawHill Education, 9th Edition,2019.
2. **V Ganesan,** Internal Combustion Engines, McGraw-Hill, 4th Edition, 2017.

E-Books / Web References

1. Working of IC engine, https://www.youtube.com/watch?v=DZt5xU44IfQ
2. Working of Refrigerator, https://www.youtube.com/watch?v=7NwxMyqUyJw
3. Working of Thermal Power Plant, https://www.youtube.com/watch?v=IdPTuwKEfmA

MOOCs

1. NPTEL Course on APPLIED THERMODYNAMICS FOR ENGINEERS by Dr. Dipankar N. Basu, Associate Professor, Department of Mechanical Engineering, Indian Institute of Technology Guwahati https://nptel.ac.in/courses/112/103/112103275/

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2. NPTEL Course on ENGINE EMISSIONS by Prof B P Pundir, Department of Mechanical Engineering, Indian Institute of Technology Kanpur https://nptel.ac.in/courses/112/104/112104033/

Scheme of Examination:

Semester End Examination (SEE):

SEE Question paper is to be set for 100 marks and the marks scored will be proportionately reduced to 50. There will be two full questions (with a maximum of four sub questions) from each module carrying 20 marks each. Students are required to answer any **five full questions** choosing at least **one full question from each module.**

Continuous Internal Evaluation (CIE):

Three Tests are to be conducted for 40 marks each. Average of Marks scored in each test is added to test component. CIE is executed by way of quizzes / Alternate Assessment Tools (AATs), and three tests.

Some possible AATs:

Assignments/ group activity / any other.

Typical Evaluation pattern for regular courses is shown in Table 2.

Table 2: Distribution of weightage for CIE & SEE of Regular courses

	Component	Marks	Total Marks
CIE	CIE Test-1	**40**	**50**
	CIE Test-2	**40**	
	CIE Test-3	**40**	
	Quiz /AAT	**10**	
SEE	Semester End Examination	**100**	**50**
Grand Total			**100**

CO/PO Mapping															
CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO34.1	3	2	2	1		1						1		1	
CO34.2	3	2	2	1		1						1		1	
CO34.3	3	2	2	1		1	1			1		1		1	
CO34.4	3	2	2	1		1	1			1		1		1	
CO34.5	3	2	2	1		1	1			1		1		1	
Average	**3**	**2**	**2**	**1**		**1**	**1**			**1**		**1**		**1**	

Low - 1: Medium - 2: High - 3

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SEMESTER – III

Course: MATERIAL SCIENCE AND METALLURGY

Course Code	**21MED35**	**CIE Marks**	**50**
Hours/Week (L: T: P)	**3 : 0 : 0**	**SEE Marks**	**50**
No. of Credits	**3**	**Examination Hours**	**03**

Prerequisites: Elements of Mechanical Engineering

Course Objectives: To enable students to apply the knowledge of materials and alloys by making them learn the:

CLO1	Basics of crystal structure and mechanism of nucleation in solids.
CLO2	Cooling curves and transformation diagrams of metals and alloys.
CLO3	Principles and varied methods of het treatment and its emphasis on structure property correlation of metals and alloys.
CLO4	Deformation and fracture mechanisms in metals and alloys.
CLO5	Trends in material technology with focus on nanomaterials, composites.

Content	No. of Hours/ RBT levels
Module 1 **Introduction to Crystal Structure:** Introduction, crystal structures, packing factor of cubic and HCP, structure, coordination number, crystal imperfections point, & line defects, Diffusion, Diffusion Mechanisms, Fick's laws of diffusion. **Homogeneous and heterogeneous nucleation**: Mechanism of solidification – nucleation and crystal growth, dendritic growth. Phases-single phase and multiphase solids, Gibb's phase rule, solid solutions and types, Intermediate phases, Types of phase diagrams.	**08 Hours / L1, L2, L3**
Module 2 **Cooling Curves and TTT Diagrams** Cooling curve for pure iron, Fe-C equilibrium diagrams, study of iron-carbon system in detail with emphasis on the invariant reactions **TTT Diagrams**: Drawing of TTT diagram, TTT diagram for hypo & hypereutectoid steels, effect of alloying elements.	**08 Hours / L1, L2, L3**
Module 3 **Heat treatment Processes** Annealing, Normalizing, Hardening, Tempering, Mar tempering, Austempering, Concept of harden ability, Factors affecting harden ability. Surface hardening methods: carburizing, cyaniding, nit riding, flame hardening and induction hardening. **Introduction to Nanotechnology** Nanomaterial processing and fabrication, application	**08 Hours / L1, L2, L3**

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of Nano materials in electronics, energy, automobiles, textile, sports, domestic appliances, biotechnology, medicine, space and defence.	
Module 4 **Mechanical Metallurgy**: Plastic deformation, slip and twinning. Fracture: types, stages in cup & cone fracture, Griffith's criterion. **Fatigue and creep:** fatigue tests, mechanism, S-N curves, Factors affecting fatigue life. Various stages of creep, Mechanisms of creep, effect of temperature, creep fracture.	**08 Hours / L1, L2, L3**
Module 5 **Engineering Alloys**: Steel: Method of designation as per AISI–SAE. Properties, composition, and uses of low, medium, and high carbon steels. **Cast irons**: Microstructures & properties of White CI, Grey CI. Aluminum alloys and Copper alloys. **Introduction to plastic, ceramics, and Composite materials:** Classification of composites- application of composites. Engineering applications of different plastics and ceramics.	**08 Hours / L1, L2, L3**

COURSE OUTCOMES: Upon completion of this course, student will be able to:

CO35.1	Analyze the fundamental concepts of bonds & crystal structures during deformation of materials
CO35.2	Infer cooling curves and its correlation to structure and property in ferrous materials
CO35.3	Interpret the varied heat treatment process and its suitability to achieve desired mechanical properties.
CO35.4	Explore the creep, fatigue, and fracture behaviour of materials.
CO35.5	Categorize the material properties with developments of latest materials

Textbooks:

1. **Smith, Mc Graw Hill,4thEdition, 2009.**Foundations of Materials Science and Engineering
2. **William D. Callister, Wiley,** 2006 Material science and Engineering and Introduction
3. **Shackle ford., & M. K. Muralidhara,** Materials Science, Pearson Publication, 2007

Reference books:

1. **V.Raghavan**, Materials Science and Engineering, PHI, 2002
2. **Donald R. Askland and Pradeep .P. Phule**, The Science and Engineering of Materials, Cengage Learning 4lhEd., 2003

E-Books / Web References

1. **V Raghavan,** Materials science and Engineering by PHI,6th Edition,2016
   http://jp.b-ok.as/ireader/3384942

MOOCs

1. http:// onlinecourses.nptel.ac.in/noc19_me70/preview
2. http://nptel.ac.in/courses/112/106/112106138/

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Scheme of Examination:

Semester End Examination (SEE):

SEE Question paper is to be set for 100 marks and the marks scored will be proportionately reduced to 50. There will be two full questions (with a maximum of four sub questions) from each module carrying 20 marks each. Students are required to answer any **five full questions** choosing at least **one full question from each module.**

Continuous Internal Evaluation (CIE):

Three Tests are to be conducted for 40 marks each. Average of three test is taken, CIE is executed by way of quizzes / Alternate Assessment Tools (AATs) for 10 marks.

Some possible AATs:

Assignments/ group activity / any other.

Typical Evaluation pattern for regular courses is shown in Table 2.

Table 2: Distribution of weightage for CIE & SEE of Regular courses

	Component	Marks	Total Marks
CIE	CIE Test-1	**40**	**50**
	CIE Test-2	**40**	
	CIE Test-3	**40**	
	Quiz/AAT	**10**	
SEE	Semester End Examination	**100**	**50**
Grand Total			**100**

CO/PO Mapping															
CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO35.1	3	2	1	1		1	1					1			1
CO35.2	3	2	1	1		1	1					1			1
CO35.3	3	2	1	1		1	1					1			1
CO35.4	3	2	1	1		1	2					1			1
CO35.5	3	2	1	1		1	2					1			1
Average	**3**	**2**	**1**	**1**		**1**	**2**					**1**			1

Low - 1: Medium - 2: High - 3

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SEMESTER – III

Course: Samskruthika Kannada

Course Code	21KSK36	CIE Marks	50
Hours/Week (L: T: P)	1 : 0 : 0	SEE Marks	50
No. of Credits	1	Examination Hours	03

ಸಾಂಸ್ಕೃತಿಕ ಕನ್ನಡ ಕಲಿಕೆಯ ಉದ್ದೇಶಗಳು:

- ಪದವಿ ವಿದ್ಯಾರ್ಥಿಗಳಾಗಿರುವುದರಿಂದ ಸಾಂಸ್ಕೃತಿಕ ಕನ್ನಡ ಜೊತೆಗೆ ಕ್ರಿಯಾತ್ಮಕ ಕನ್ನಡವನ್ನು, ಕನ್ನಡ ಸಾಹಿತ್ಯ, ಸಂಸ್ಕೃತಿ ಮತ್ತು ನಾಡು ನುಡಿಯ ಪರಿಚಯ ಮಾಡಿಕೊಡುವುದು.
- ವಿದ್ಯಾರ್ಥಿಗಳಲ್ಲಿ ಕನ್ನಡ ಭಾಷೆಯ ವ್ಯಾಕರಣದ ಬಗ್ಗೆ ಅರಿವು ಮೂಡಿಸುವುದು ಮತ್ತು ಕನ್ನಡ ಭಾಷಾ ರಚನೆಯಲ್ಲಿನ ನಿಯಮಗಳನ್ನು ಪರಿಚಯಿಸುವುದು.
- ಕನ್ನಡ ಭಾಷಾ ಬರಹದಲ್ಲಿ ಕಂಡುಬರುವ ದೋಷಗಳು ಹಾಗೂ ಅವುಗಳ ನಿವಾರಣೆ.
- ಸಾಮಾನ್ಯ ಅರ್ಜಿಗಳು, ಸರ್ಕಾರಿ ಮತ್ತು ಅರೆ ಸರ್ಕಾರಿ ಪತ್ರವ್ಯವಹಾರದ ಬಗ್ಗೆ ಅರಿವು ಮೂಡಿಸುವುದು.
- ಭಾಷಾಂತರ ಮತ್ತು ಪ್ರಬಂಧ ರಚನೆ ಬಗ್ಗೆ ಆಸಕ್ತಿ ಮೂಡಿಸುವುದು.
- ಕನ್ನಡ ಭಾಷಾಭ್ಯಾಸ, ಸಾಮಾನ್ಯ ಕನ್ನಡ ಹಾಗೂ ಆಡಳಿತ ಕನ್ನಡದ ಪದಗಳ ಪರಿಚಯ ಮಾಡಿಕೊಡುವುದು.

ಸಾಂಸ್ಕೃತಿಕ ಕನ್ನಡ ಪಠ್ಯಪುಸ್ತಕ

ಪರಿವಿಡಿ

ಭಾಗ – ಒಂದು ಲೇಖನಗಳು (ಕನ್ನಡ ನಾಡು, ನುಡಿ ಮತ್ತು ಸಂಸ್ಕೃತಿಗೆ ಸಂಬಂಧಿಸಿದ ಲೇಖನಗಳು)

೧. ಕರ್ನಾಟಕ ಸಂಸ್ಕೃತಿಗೆ : ಹಂಪ ನಾಗರಾಜಯ್ಯ

೨. ಕರ್ನಾಟಕದ ಏಕೀಕರಣ : ಒಂದು ಅಪೂರ್ವ ಚರಿತ್ರೆ – ಜಿ. ವೆಂಕಟಸುಬ್ಬಯ್ಯ

೩. ಆಡಳಿತ ಭಾಷೆಯಾಗಿ ಕನ್ನಡ – ವಿಶಾವಿಯ ಆಡಳಿತ ಕನ್ನಡ ಪುಸ್ತಕದಿಂದ ಆಯ್ದ ಲೇಖನ*

ಭಾಗ – ಎರಡು ಕಾವ್ಯ ಭಾಗ (ಆಧುನಿಕ ಪೂರ್ವ)

೪. ವಚನಗಳು : ಬಸವಣ್ಣ, ಅಕ್ಕಮಹಾದೇವಿ, ಅಲ್ಲಮಪ್ರಭು, ಆಯ್ದಕ್ಕಿ ಮಾರಯ್ಯ, ಜೇಡರ ದಾಸಿಮಯ್ಯ, ಆಯ್ದಕ್ಕಿ ಲಕ್ಕಮ್ಮ

೫. ಕೀರ್ತನೆಗಳು : ಅದರಿಂದೇನು ಫಲ ಇದರಿಂದೇನು ಫಲ – ಪುರಂದರದಾಸ

ತಲ್ಲಣಿಸದಿರು ಕಂಡ್ಯತಾಳು ಮನವೆ – ಕನಕದಾಸ

೬. ತತ್ವಪದಗಳು : ಸಾವಿರ ಕೊಡಗಳ ಸುಟ್ಟು – ಶಿಶುನಾಳ ಷರೀಫ

ಶಿವಯೋಗಿ – ಬಾಲಲೀಲಾ ಮಹಾಂತ ಶಿವಯೋಗಿ

೭. ಜನಪದ ಗೀತೆ : ಬೀಸುವ ಪದ, ಬಡವರಿಗೆ ಸಾವ ಕೊಡಬೇಡ

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ಭಾಗ – ಮೂರು ಕಾವ್ಯ ಭಾಗ (ಆಧುನಿಕ)

೮. ಮಂಕುತಿಮ್ಮನ ಕಗ್ಗ : ಡಿ.ವಿ.ಜಿ.

೯. ಕುರುಡು ಕಾಂಚಾಣಾ : ದ.ರಾ. ಬೇಂದ್ರೆ

೧೦. ಹೊಸಬಾಳಿನ ಗೀತೆ : ಕುವೆಂಪು

೧೧. ಹೆಂಡತಿಯ ಕಾಗದ : ಕೆ.ಎಸ್. ನರಸಿಂಹಸ್ವಾಮಿ

೧೨. ಮಬ್ಬಿನಿಂದ ಮಬ್ಬಿಗೆ : ಜಿ.ಎಸ್. ಶಿವರುದ್ರಪ್ಪ

೧೩. ಆ ಮರ ಈ ಮರ : ಚಂದ್ರಶೇಖರ ಕಂಬಾರ

೧೪. ಚೋಮನ ಮಕ್ಕಳ ಹಾಡು : ಸಿದ್ಧಲಿಂಗಯ್ಯ

ಭಾಗ – ನಾಲ್ಕು ತಾಂತ್ರಿಕ ವ್ಯಕ್ತಿ ಪರಿಚಯ, ಕಥೆ ಮತ್ತು ಪ್ರವಾಸ ಕಥನ

೧೫. ಡಾ. ಸರ್ ಎಂ. ವಿಶ್ವೇಶ್ವರಯ್ಯ – ವ್ಯಕ್ತಿ ಮತ್ತು ಐತಿಹ್ಯ : ಎ ಎನ್ ಮೂರ್ತಿರಾವ್

೧೬. ಯುಗಾದಿ : ವಸುಧೇಂದ್ರ

೧೭. ಮೇಗಾನೆ ಎಂಬ ಗಿರಿಜನ ಪರ್ವತ : ಹಿ.ಚಿ.ಬೋರಲಿಂಗಯ್ಯ

ಭಾಗ – ಐದು ವಿಜ್ಞಾನ ಮತ್ತು ತಂತ್ರಜ್ಞಾನ

೧೮. ಕರಕುಶಲ ಕಲೆಗಳು ಮತ್ತು ಪರಂಪರೆಯ ವಿಜ್ಞಾನ : ಕರೀಗೌಡ ಬೀಚನಹಳ್ಳಿ

೧೯. "ಕ" ಮತ್ತು "ಬ" ಬರಹ ತಂತ್ರಾಂಶಗಳು ಮತ್ತು ಕನ್ನಡದ ಟೈಪಿಂಗ್*

೨೦. ಕನ್ನಡ – ಕಂಪ್ಯೂಟರ್ ಶಬ್ದಕೋಶ*

೨೧. ತಾಂತ್ರಿಕ ಪದಕೋಶ : ತಾಂತ್ರಿಕ ಹಾಗೂ ಪಾರಿಭಾಷಿಕ ಕನ್ನಡ ಪದಗಳು*

*(ವಿತಾವಿ ಯ ಆಡಳಿತ ಕನ್ನಡ ಪುಸ್ತಕದಿಂದ ಆಯ್ದ ಲೇಖನಗಳು – ಡಾ. ಎಲ್. ತಿಮ್ಮೇಶ ಮತ್ತು ಪ್ರೋ.ವಿ.ಕೇಶವಮೂರ್ತಿ)

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SEMESTER – III

Course: Balake Kannada (for Non-Kannadiga Students)

Course Code	21KBK36	CIE Marks	50
Hours/Week (L: T: P)	1 : 0 : 0	SEE Marks	50
No. of Credits	1	Examination Hours	03

Course Learning Objectives:

The course will enable the students to understand Kannada and communicate (converse) in Kannada language.

Table of Contents

- Abbreviations
- Key to Transcription
- Easy learning of a Kannada Language: A few tips
- Necessity of learning a local langauge:
- Tips to learn the language with easy methods.
- Hints for correct and polite conservation
- About Kannada Language (Kannada Bhashe)
- Eight Kannada authors who have won 'Jnanpith Award'
- Information about Karnataka State

Part : I

Instructions to Teachers

1. How to Teach the BaLake Kannada Book
2. Methods to be followed in Teaching of all the chapters/ concepts

Chapter – 1 Listening and Speaking - KelisikoLLuvudu mattu Maatanaduvudu

1. Pronouns – SarvanaamagaLu
2. Adjectives – Naama VisheshaNagaLu
3. Verbs – KriyapadagaLu
4. Adverbs – KriyavisheshaNagaLu

Necessity of learning a local langauge:

The learning of local language,

- Encourages the respect for other people: it fosters an understanding of the interrelation of language and human nature.

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- Expands one's view of the world, liberalizes one's experiences, and makes one more flexible and tolerant.
- Limits the barriers between people: barriers cause distrust and fear.
- Opens the door to art, music, dance, fashion, cuisine, film, philosophy, science…etc.
- Leads to an appreciation of cultural diversity.
- Helps fluent communication.

Language learning helps to develop strong cognitive skills, such as a better concept formation, mental flexibility, multitasking, listening skills and problem-solving, in addition to improve social interaction and also encourages the connection between peers.

Use of local language help to mingle with the local society and ensures security, pleasant welcoming from auto/cab drivers, shop owners, employees of local government etc., and make the living easier and more comfortable.

Tips to learn the language with easy methods.

Apart from the conventional method of learning from teachers, the learning of language can be accelerated by adopting the following methods.

1. Love the learning without boredom.
2. Talk to classmates and others in Kannada without hesitation and with no concern to grammatical mistakes during the initial stages of learning the language.
3. Use English words to continue the conversation when you find difficulty in finding suitable Kannada word/s. Vocabulary improves with the use of language.
4. While reading, read aloud (not silently or in a whisper manner, but audibly so that others are not being disturbed or others can hear what is being read). Reading aloud not only helps proper/ correct pronunciation of words with variation in pitch, pace, volume, pauses etc., but also produces a fluent and enjoyable delivery during conversation/debate/presentation.
5. Listen to Kannada news and watch Kannada movies.
6. Listen to Kannada FM radios for news, live conversations and songs.
7. Use online applications (apps) for fast learning.

Easy learning of a Kannada Language: A few tips

1. Watching Kannada movies (preferably with subtitles), can be of great help. This is an important and entertaining way to improve your language skills.
2. Do not hesitate. Speak the language at every possible opportunity.
3. Never mind if you are using less Kannada and more English words. Kanglish is anyway popular in Bangalore. However constantly try to improve your Kannada vocabulary.
4. Watch Kannada news. This is not only helpful in learning the language, but will help you to know your city better.
5. If you are a user of public transport, carefully listen to co-passengers' conversations.
6. Enjoy the local tang of the language by listening to Kannada FM stations.
7. Do not completely rely on 'Learn Kannada in 30 days' type of books. Many Bangaloreans will fail to comprehend your textbook language and you are sure to face some embarrassment, if you go strictly by books.

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Hints for correct and polite conservation

1. Be vigilant about the verbs, the pronouns, the genders and tense required for day to day Conversation.
2. Pronounce the words properly.
3. Use plural form to address others.
4. Use simple sentences for conversation.

About Kannada Language (Kannada Bhashe)

- Kannada is one of the classical (Shastreeya) languages of India since November 01, 2008, and is the official language of the Karnataka state.
- This language is not just confined within the borders of Karnataka, for you will find it spoken by people in parts of the neighboring states of Andhra Pradesh, Tamil Nadu and Maharashtra. Kannada is spoken in its various dialects by Six to Seven million people across the globe. It is one among the top 40 most spoken languages of the world.
- Spoken Kannada is in use since 2500 years, and has its own script since 1900 years. Spoken Kannada varies according to the regions of Karnataka, while the written form of Kannada remains almost the same. Kannada is the third oldest language of India (after Sanskrit and Tamil).
- The written form of Kannada is phonetic and it is written as it is spoken.
- The first Kannada-English Dictionary (ShabdaKosha) was compiled in 1894 by a German priest, Rev. Ferdinand Kittel. He also wrote a book on Kannada Grammar entitled, "A Grammar of the Kannada Language: Comprising the Three Dialects of the Language".
- Several noted centuries old literary works of Kannada have been translated into Sanskrit, and other languages.
- November 1st of every year is celebrated as Kannada Rajyotsava Day throughout Karnataka state and is declared as a state holiday. This was the day that the name Karnataka was given to the Mysore state in the year 1973.

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SEMESTER – III

Course: Constitution of India and Professional Ethics

Course Code	**21CPH36**	**CIE Marks**	**50**
Hours/Week (L: T: P)	**1 : 0 : 0**	**SEE Marks**	**50**
No. of Credits	**1**	**Examination Hours**	**03**

Course Objectives: This course will enable the students to:

CLO1	Know the fundamental political codes, structure, procedures, powers, and duties of Indian government institutions, fundamental rights, directive principles, and the duties of citizens.
CLO2	Understand engineering ethics and their responsibilities; identify their individual roles and ethical responsibilities towards society.
CLO3	Know about the cybercrimes and cyber laws for cyber safety measures.

Content	No. of Hours
Module 1 Introduction to Indian Constitution: The Necessity of the Constitution, The Societies before and after the Constitution adoption. Introduction to the Indian constitution, The Making of the Constitution, The Role of the Constituent Assembly. The Preamble of Indian Constitution & Key concepts of the Preamble. Salient features of India Constitution.	**03 Hours**
Module 2 FR's, FD's and DPSP's: Fundamental Rights and its Restriction and limitations in different Complex Situations. Directive Principles of State Policy (DPSP) and its present relevance in our society with examples. Fundamental Duties and its Scope and significance in Nation building.	**03 Hours**
Module 3 Union Executive : Parliamentary System, Union Executive – President, Prime Minister, Union Cabinet, Parliament - LS and RS, Parliamentary Committees, Important Parliamentary Terminologies. Supreme Court of India, Judicial Reviews and Judicial Activism.	**03 Hours**
Module 4 State Executive & Elections, Amendments and Emergency Provisions: State Executive, Election Commission, Elections & Electoral Process. Amendment to Constitution (How and Why) and Important Constitutional Amendments till today. Emergency Provisions.	**03 Hours**
Module 5 Professional Ethics: Ethics & Values. Types of Ethics. Scope & Aims of Professional & Engineering Ethics. Positive and Negative Faces of Engineering Ethics. Clash of Ethics, Conflicts of Interest. The impediments to Responsibility. Trust & Reliability in Engineering, IPRs (Intellectual Property Rights), Risks, Safety and liability in Engineering.	**03 Hours**

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COURSE OUTCOMES: Upon completion of this course, student will be able to

CO36.1	Analyse the basic structure of Indian Constitution.
CO36.2	Remember their Fundamental Rights, DPSP's and Fundamental Duties (FD's) of our constitution.
CO36.3	know about our Union Government, political structure & codes, procedures
CO36.4	Understand our State Executive & Elections system of India
CO36.5	Remember the Amendments and Emergency Provisions, other important provisions given by the constitution.

TEXTBOOKS:

1. "Constitution of India" (for Competitive Exams) - Published by Naidhruva Edutech Learning Solutions, Bengaluru. – 2022.
2. "Engineering Ethics", M.Govindarajan, S.Natarajan, V.S.Senthilkumar, Prentice –Hall, 2004.

REFERENCE BOOKS:

1. "Samvidhana Odu" - for Students & Youths by Justice HN Nagamohan Dhas, Sahayana, kerekon.
2. "Constitution of India, Professional Ethics and Human Rights" by Shubham Singles, Charles E. Haries, and et al: published by Cengage Learning India, Latest Edition – 2019.
3. "Introduction to the Constitution of India", (Students Edition.) by Durga Das Basu (DD Basu): Prentice –Hall, 2008.
4. "The Constitution of India" by Merunandan K B: published by Merugu Publication, Second Edition, Bengaluru.

Scheme of Examination: There is no Semester End Examination for this course. The assessment is based on Continuous Internal Evaluation only.

Continuous Internal Evaluation (CIE): Three Tests are to be conducted for 40 marks each. The average of the three tests are taken for computation of CIE. The assignment/Quiz/ Alternate Assessment Tools would be for a total of 10 marks**.** All quizzes are conducted online. Faculty may adopt innovative methods for conducting quizzes effectively. Typical Evaluation pattern for this course is shown in Table

Table 2: Distribution of weightage for CIE

	Component	Marks	Total Marks
CIE	CIE Test-1	**40**	**50**
	CIE Test-2	**40**	
	CIE Test-3	**40**	
	Quiz 1/AAT	**10**	
	Quiz 2/AAT	**10**	
SEE	Semester End Examination	**100**	**50**
		Grand Total	**100**

CO/PO Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO36.1						2	1	1	1	1		1				
CO36.2						2	1	1	1	1		1				
CO36.3						1	1	1	1	1		1				
CO36.4						1	1	1	1	1		1				
CO36.5						1	1	1	1	1		1				

Low - 1: Medium - 2: High - 3

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SEMESTER – III

Course: Ability Enhancement Course – I: Modelling and 3D printing

Subject Code	21MED37	CIE Marks	50
Hours/Week (L: T: P)	0 : 0 : 2	SEE Marks	50
Credits	01	Examination Hours	03

Course Objectives: This course will enable the students to:

CLO1	Impart students to the fundamentals of various 3D Printing Techniques for application to various industrial needs.
CLO2	Use critical thinking skills in creating their models.
CLO3	Creates three-dimensional (3D) solid objects from digital files.

Content	No. of Hours/ RBT levels
Module 1 Introduction to additive manufacturing, Fusion Deposition Modeling, CAD Data formats, STL format. 3D Modelling of a single component, CAD Data Exchange, Generation of .stl files.	**06 Hours / L3**
Module 2 Various forms of raw material and their desired properties, Printing of product on an available AM machine, Post processing techniques.	**06 Hours / L3**

COURSE OUTCOMES: Upon completion of this course, student will be able to:

CO37.1	Develop CAD models for 3D printing
CO37.2	Import and Export CAD data and generate .stl file.
CO37.3	Select a specific material for the given application
CO37.4	Produce a product using Fusion Deposition Modeling (FDM).

TEXTBOOKS:

1. Samuel N Bernier, Design for 3D Printing - Scanning, Creating, Editing, Remixing, and Making in Three Dimensions, Shroff Publishers & Distributors Pvt Ltd, 2016
2. Avikshit Saras, 3D Printing Made Simple, BPB Publications, 2019.

CO/PO Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO37.1	3	2	2	-	3	1	1	-	2	2	-	3	3	-	-
CO37.2	2	2	2	-	3	1	1	-	2	2	-	3	3	-	-
CO37.3	2	2	2	-	3	1	1	-	2	2	-	3	3	-	-
CO37.4	2	2	2	-	3	1	1	-	2	2	-	3	3	-	-
Average	**2**	**2**	**2**	**-**	**3**	**2**	**2**	**-**	**2**	**2**	**-**	**2**	**3**	**-**	**-**

Low - 1: Medium - 2: High - 3

SEMESTER – III

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Course: ADDITIONAL MATHEMATICS
(For Lateral Entry students - Common to all branches)

Course Code	21MATDIP31	CIE Marks	100
Hours/Week (L: T: P)	2 : 2 : 0	SEE Marks	-
No. of Credits	0	Examination Hours	-

Course Objectives: To enable the students to apply the knowledge of Mathematics in various fields of engineering by making them to learn:

CLO1	Derivatives, Polar curves and Radius of curvature
CLO2	Partial Derivatives and Jacobians
CLO3	Multiple integrals, beta & gamma functions
CLO4	Ordinary and Partial differential equations

Content	No. of Hours/ RBT levels
Module 1 Successive differentiation - simple problems. Polar Curves - angle between radius vector and tangent, angle between two curves, Pedal equation. Taylor's and Maclaurin's series for function of one variable.	**8 Hours L2, L3**
Module 2 Evaluation of Indeterminate forms. Partial derivatives, Differentiation of implicit and composite functions. Jacobians. Taylor's series for functions of two variables.	**8 Hours L2, L3**
Module 3 Multiple Integrals-Double integrals- direct evaluation, change of order of integration, change of variables. Triple integrals-direct evaluation. Beta and Gamma functions, relation between beta and gamma function.	**8 Hours L2, L3**
Module 4 Solution of first order and first degree differential equations – Variable Separable, Exact and Bernoulli's differential equations. Second order linear differential equation with constant Coefficients-Inverse differential operators. Cauchy's and Legendre's Linear differential equations.	**8 Hours L2, L3**
Module 5 Formation of partial differential equations by elimination of arbitrary constants and functions. Solution of non-homogeneous PDE by direct integration, homogeneous PDEs involving derivative with respect to one independent variable only.	**8 Hours L2, L3**

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COURSE OUTCOMES: Upon completion of this course, student will be able to:

CO31.1	Apply the knowledge of differential calculus to solve problems related to curvature, maxima & minima of a function and Jacobians
CO31.2	Evaluate double and triple integrals
CO31.3	Evaluate definite integrals using beta and gamma functions
CO31.4	Solve linear differential equations of first and second order with constant/variable coefficients
CO31.5	Solve partial differential equations.

Textbooks:

1. B. S. Grewal, Higher Engineering Mathematics, Khanna Publishers 44th Edition, 2017
2. B.V. Ramana, Higher Engineering Mathematics, Tata McGraw-Hill, 2006

Reference books:

1. E. Kreyszig , Advanced Engineering Mathematics, John Wiley & Sons 10th Edition, 2016
2. N.P.Bali and Manish Goyal, A Textbook of Engineering Mathematics, Laxmi Publications 6th Edition, 2014

Scheme of Examination:
Semester End Examination (SEE): There will be no SEE examination for this course.

Continuous Internal Evaluation (CIE):
Three Tests are to be conducted for 40 marks each. Average of Marks scored in all three tests is added to test component. CIE is executed by way of quizzes / Alternate Assessment Tools (AATs), and three tests. **Some possible AATs:** seminar/assignments/ mini-projects/ concept videos/ partial reproduction of research work/ group activity/ any other.

Typical Evaluation pattern for regular courses is shown in Table 2.

Table 2: Distribution of weightage for CIE & SEE of Regular courses

	Component	Marks	Total Marks
CIE	CIE Test-1	**40**	**50**
	CIE Test-2	**40**	
	CIE Test-3	**40**	
	Assignment	**10**	
Grand Total (Final CIE x 2)			**100**

CO/PO Mapping																
CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO31.1	3	2	1									2				
CO31.2	3	2	1									2				
CO31.3	3	2	1									2				
CO31.4	3	2	1									2				
CO31.5	3	2	1									2				
Average	3	2	1									2				

Low -1: Medium-2: High-3

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IV SEMESTER

SYLLABUS

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SEMESTER – IV

Course: Transforms Calculus and Numerical Techniques (Common for ME/AE)

Course Code	**21MAT41C**	**CIE Marks**	**50**
Hours/Week (L: T: P)	**2 : 2 : 0**	**SEE Marks**	**50**
No. of Credits	**3**	**Examination Hours**	**03**

Course Objectives: To enable students to apply the knowledge of Mathematics in various fields of engineering by making them to learn:

CLO1	Laplace Transforms
CLO2	Fourier series and Fourier Transforms
CLO3	Numerical Methods

Content	No. of Hours/ RBT levels
Module 1 Laplace transforms of elementary functions, Unit-step and Dirac delta functions. Inverse Laplace Transforms, Solution of second order linear differential equations using Laplace transforms.	**08 Hours L2, L3**
Module 2 Fourier series of periodic functions, half range Fourier sine and cosine series. Infinite Fourier transforms, Fourier sine and cosine transforms. Inverse Fourier transforms.	**08 Hours L2, L3**
Module 3 Solution of algebraic and transcendental equations: Regula-Falsi and Newton-Raphson method. Finite differences: Newton's forward and backward difference formulae. Newton's divided difference formula and Lagrange's interpolation formula. Numerical integration: Simpson's 1/3rd, 3/8th, Weddle's rule.	**08 Hours L2, L3**
Module 4 Numerical solution of ordinary differential equations of first order and first degree using Modified Euler method, Runge-Kutta method of fourth order, Milne's and Adam-Bashforth predictor and corrector methods. Numerical solution of second order ordinary differential equations: Runge-Kutta method and Milne's method.	**08 Hours L2, L3**
Module 5 One dimensional wave and heat equation. Solution of heat and wave equation by method of separation of variables. Two-dimensional heat flow, Solution of Laplace's equation, Laplace's equation in polar coordinates. Two dimensional wave equation. Numerical solution of heat and wave equations.	**08 Hours L2, L3**

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COURSE OUTCOMES: Upon completion of this course, student will be able to:

CO41.1	Determine Laplace and inverse Laplace transforms of given functions and solve linear differential equations
CO41.2	Determine Fourier series and Fourier Transform of given function.
CO41.3	Apply numerical techniques to solve algebraic and transcendental equations.
CO41.4	Apply numerical techniques for interpolation and to evaluate definite integrals.
CO41.5	Solve ordinary differential equations of first and second order using single step and multistep numerical methods
CO41.6	Solve problems related to heat and wave equations

Textbooks:

1. B. S. Grewal, Higher Engineering Mathematics, Khanna Publishers 44th Edition, 2017
2. B.V. Ramana, Higher Engineering Mathematics, Tata McGraw-Hill, 2006

Reference books:

1. E. Kreyszig, Advanced Engineering Mathematics, John Wiley & Sons 10th Edition, 2016
2. N.P.Bali and Manish Goyal, A Textbook of Engineering Mathematics, Laxmi Publications 6th Edition, 2014

Scheme of Examination:
Semester End Examination (SEE): SEE Question paper is to be set for 100 marks and the marks scored will be proportionately reduced to 50. There will be two full questions (with a maximum of three sub questions) from each module carrying 20 marks each. Students are required to answer any **five full questions** choosing at least **one full question from each module.**

Continuous Internal Evaluation (CIE): Three Tests are to be conducted for 40 marks each. Average of Marks scored in all three tests is added to test component. CIE is executed by way of quizzes / Alternate Assessment Tools (AATs), and three tests. **Some possible AATs:** seminar/assignments/ mini-projects/ concept videos/ partial reproduction of research work/ group activity/ any other.

Typical Evaluation pattern for regular courses is shown in Table 2.

Table 2: Distribution of weightage for CIE & SEE of Regular courses

	Component	Marks	Total Marks
CIE	CIE Test-1	**40**	**50**
	CIE Test-2	**40**	
	CIE Test-3	**40**	
	Assignment	**10**	
SEE	Semester End Examination	**100**	**50**
Grand Total			**100**

CO/PO Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO41.1	3	2	1									3				
CO41.2	3	2	1									3				
CO41.3	3	2	1									3				
CO41.4	3	2	1									3				
CO41.5	3	2	1									3				
CO41.6	3	2	1									3				
Average	3	2	1									3				

Low -1: Medium-2: High-3

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SEMESTER – IV

Course: MECHANICAL MEASUREMENTS AND METROLOGY (Integrated)

Course Code	**21MED42**	**CIE Marks (Theory + Lab)**	**30 + 20 = 50**
Hours/Week (L: T: P)	**3 : 0 : 2**	**SEE Marks**	**50**
No. of Credits	**4**	**Examination Hours**	**03**

Prerequisites: Engineering Physics

Course Objectives: This course will enable the students to

CLO1	Understand the standards of measurement, errors in measurement, limits and fits as applied to industrial specific standards.
CLO2	Know gauges, Basics of Geometrical Dimensioning and Tolerances.
CLO3	Know the types of comparators, principles and devices used for angular measurement.
CLO4	Understand static characteristics of measurement, types and principle of working of transducers.
CLO5	Understand the principles of strain, temperature and pressure measurement.

Content	**No. of Hours/ RBT levels**
Module 1 **Standards of measurement**: Definition and Objectives of metrology, line and end standard, Transformation from line standard to end standard, calibration of end standards, Characteristics/Numericals. Definitions and concept of accuracy, precision. Errors in measurement, classification of errors. **Tolerances:** Definition of tolerance, specification in assembly, principle of interchange ability and selective assembly. Concept of limits, size and tolerances, compound tolerances, accumulation of tolerances. **Laboratory:** *Laboratory Exercise – I, II*	**08 Hours / L2**
Module 2 **System of Limits, Fits, Tolerance and Gauges:** Hole base system & shaft base system, Limit gauging, classification of gauges, Taylor's principle, Numerical on limit gauge design. **Geometrical Dimensioning and Tolerances:** Types of GD&T, Datum, Machine tool tests to check for Straightness, Flatness, Parallelism, Squareness, Roundness, Cylindricity, Runout Coordinate Measuring Machines: Structure, Probes, Operation, Applications of CMM. **Laboratory:** *Laboratory Exercise – III*	**08 Hours / L3**
Module 3 **Comparators:** Introduction to Comparators, characteristics, and classification of comparators. Measurements using Autocollimator, NPL flatness interferometer, Laser interferometer. Angular measurements, Bevel Protractor, Sine Principle and use of Sine bars, Sine centre, use of angle gauges, (numerical on building of angles) **Laboratory:** *Laboratory Exercise – IV, V and VI*	**08 Hours / L3**

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Module 4 **Measurement systems and methods:** Definition, Significance of measurement, Generalized measurement system, Static characteristics- Accuracy, Precision, Calibration, Threshold, Sensitivity, Hysteresis, Repeatability, Linearity, Loading effect, Dynamic characteristics- System response, Time delay. **Transducers:** Transfer efficiency, primary and secondary transducers, and classification of transducers with examples. Quality attributes of transducers, intermediate modifying devices. **Measurement of Force and Torque:** Basic principles, proving ring, torque measurement, hydraulic dynamometer.	**08 Hours / L3**
Module 5 **Strain measurement**: Theory of strain gauges, Types, Electrical resistance strain gauge, Preparation and mounting of Strain gauges, Gauge factor, Methods of strain measurement. **Pressure and Temperature measurement**: Basic principles, use of elastic members, Bridgeman gauge, McLeod gauge, Thermocouple, Laws of Thermocouple, and Optical Pyrometer. **Laboratory:** *Laboratory Exercise – VII and VIII*	**08 Hours / L3**

COURSE OUTCOMES: Upon completion of this course, student will be able to

CO42.1	Interpret the concept of standards in measurement, tolerances, interchangeability in measurements.
CO42.2	Apply the concepts of limits, fits, tolerances, geometrical tolerances in assemblies and industry components.
CO42.3	Inspect the process of linear and angular measurements as applied to a few machine made components.
CO42.4	Infer on the concept of principles of transducers and their measurement of force and torque.
CO42.5	Demonstrate the measurement of pressure, temperature and strain measurement.

Laboratory:

Exercise Number	Experiment	No. of Hours/RBT Levels
I & II	1. Calibration of Micrometer using slip gauges. 2. Calibration of Vernier caliper	**02 Hours/L3**
III & IV	3. Measurements of surface roughness using Tally Surf/Mechanical Comparator.	**02 Hours/L3**
V & VI	4. Measurement of angle using Bevel protractor 5. Measurement of angle using Sine Centre / Sine bar. 6. Measurements using Optical Projector	**04 Hours/L3**
VII VIII	7. Calibration of Load cell using standard weights 8. Calibration of Pressure Gauge using Bourdon tube measurement.	**02 Hours/L3**

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Textbooks:

1. **Beckwith Marangoni and Lienhard** Mechanical Measurements by, Pearson Education, 6th Ed.,2006.
2. **B C Nakra, K K Chaudhry** Instrumentation, Measurement and Analysis, McGraw–Hill, 4th Edition.
3. **R.K. Jain Engineering** Metrology, Khanna Publishers, 2009.

Reference books:

1. **N.V. Raghavendra and L. Krishnamurthy**, Engineering Metrology and Measurements, Oxford University Press.
2. **Ernest Deoblin**, Deoblin's Measurement system, Dhanesh manick, McGraw–Hill
3. **Bentley**, Engineering Metrology and Measurements, Pearson Education.

MOOCs

1. https://onlinecourses.nptel.ac.in/noc19_me70/preview
2. https://nptel.ac.in/courses/112/106/112106138/

Scheme of Examination: (Integrated courses)

Semester End Examination (SEE): SEE Question paper is to be set for 100 marks and the marks scored will be proportionately reduced to 50. There will be two full questions (with a maximum of four sub questions) from each module carrying 20 marks each. Students are required to answer any **five full questions** choosing at least **one full question from each module.**

Note: The laboratory assessment would be restricted to only the CIE evaluation.

Continuous Internal Evaluation (CIE): Three Tests are to be conducted for 40 marks each. The average of the three tests are taken for computation of CIE on a scale of 30, the CIE would also include laboratory evaluation for 20 marks. The laboratory marks of 20 would comprise of 10 marks for regular laboratory assessment to include lab record and observation. 10 marks would be exclusive for laboratory internal assessment test to be conducted at the end of the semester.

Typical Evaluation pattern for integrated courses is shown in the Table below

Table: Distribution of weightage for CIE & SEE of Integrated courses

	Component	Marks	Total Marks
CIE	CIE Test-1	**30**	**50**
	CIE Test-2	**30**	
	CIE Test-3	**30**	
	Laboratory	**20**	
SEE	Semester End Examination	**100**	**50**
		Grand Total	**100**

CO/PO Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO42.1	3	1	1	1		1	1	1	1			1			3
CO42.2	3	1	1	1		1	1	1	1			1			3
CO42.3	3	1	1	1		1	1	1	1			1			3
CO42.4	3	1	1	1		1	1	1	1			1			3
CO42.5	3	1	1	1		1	1	1	1			1			3
Average	**3**	**1**	**1**	**1**		**1**	**1**	**1**	**1**			**1**			**3**

Low - 1: Medium - 2: High - 3

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SEMESTER – IV

Course: MECHATRONICS

Course Code	21MED43	CIE Marks	50
Hours/Week (L: T: P)	3 : 0 : 0	SEE Marks	50
No. of Credits	3	Examination Hours	03

Course Objectives: This course will enable the students to

CLO1	Understand key elements of Mechatronics system, representation into block diagram.
CLO2	Understand principles of sensors, its characteristics, interfacing with microcontroller.
CLO3	Understand the working of sensors, actuators and interfacing with microcontrollers.

Content	No. of Hours/ RBT levels
Module 1 **Introduction**: Definition of Mechatronics, the multidisciplinary scenario in mechatronics, Evolution of Mechatronics, Objective of mechatronics Advantages and Disadvantages of Mechatronics system, Applications of Mechatronics. Mechatronics design process, Control system – Open and closed loop control systems, Basic elements of a closed-loop system (Feedback System).	**8 Hours / L1, L2, L3**
Module 2 **Microprocessor & Microcontrollers**: Introduction, Microprocessor systems, Basic elements of control systems, Microcontrollers, Difference between microprocessor and Microcontrollers. Microprocessor Architecture: Microprocessor architecture and terminology-CPU, memory and address, I/O and Peripheral devices, ALU, Instruction and Program, Assembler, Data Registers, Program Counter, Flags, Fetch cycle, write cycle, state, bus interrupts.	**8 Hours / L1, L2, L3**
Module 3 **Transducers and sensors**: Difference between transducer and sensor, Definition and classification of sensors, Performance parameters of a Sensor / Transducers, Classification of transducers, Working and applications of light sensors: Photodiode, Photoresistor, Phototransistor, Potentiometers, LVDT, Capacitance sensors, force and pressure sensors, Strain gauges, temperature sensors, proximity switches and Hall Effect sensors.	**8 Hours / L1, L2, L3**
Module 4 **DRIVES AND ACTUATORS:** Solenoids, relays, DC motor: Brush and Brushless type DC motors, AC Motor: Synchronous and Induction motors, stepper motors, Servo motor, PWM's – Pulse Width Modulation, Signal Conditioning, Analog to digital conversions, Digital to Analog conversions. **Case Studies**: Automatic Washing Machine, Automatic car parking system, Auto focus camera, Anti-lock braking system, Engine Machine System, Automatic control of water level.	**8 Hours / L1, L2, L3**

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Module 5	
Arduino as microcontroller, prototyping with breadboard, Arduino programming, Interfacing LEDs, Buzzers, Switches, Sensors, DC motors, Servo motors with Arduino, PWM on Arduino, Arduino Programming with LCD, Reading data from the computer. Raspberry pi as microprocessor (Introduction)	**8 Hours / L1, L2, L3**

COURSE OUTCOMES: Upon completion of this course, student will be able to

CO43.1	Differentiate traditional with concurrent mechatronics system design approach.
CO43.2	Differentiate between the Microprocessor & Microcontrollers in terms of their architecture, working.
CO43.3	Illustrate & summarize the working principles of Sensors along with their mathematical model.
CO43.4	Illustrate & elucidate the various elements of actuators, signal conditioning & its components
CO43.5	Develop programs for specific applications for Arduino.

Textbooks:

1. W Bolton. (2019). Mechatronics: Electronic Control Systems in Mechanical and Electrical Engineering, Pearson Education, Sixth Edition, pp. 1-682.
2. D. Shetty and R. Kolk. (2011). Mechatronics System Design, 2nd edition, SI Global Engineering

Reference books:

1. Mechatronics – HMT. (2000). Tata McGraw Hill Publishing Company Ltd.
2. David G. Alciatore and Michael B Histand. (2007). Introduction to Mechatronics and Measurement systems, Tata McGraw Hill, Third Edition.
3. Robert H. Bishop. (2002). The Mechatronics Handbook, CRC Press.

E-Books / Web References

1. **http://www.springer.com/in/book/9783642175305**
2. http://controlmanuals.com/files/Automation/Mechatronics-p1.html
3. http://www.philadelphia.edu.jo/academics/ttutunji/uploads/Book%2020MSD%20by%20Shetty.pdf

MOOCs

1. NPTEL Course: "Mechatronics" https://onlinecourses.nptel.ac.in/noc21_me27/preview
2. NPTEL Course: "Design of Mechatronic Systems" https://onlinecourses.nptel.ac.in/noc21_me129/preview

Scheme of Examination:

Semester End Examination (SEE):

SEE Question paper is to be set for 100 marks and the marks scored will be proportionately reduced to 50. There will be two full questions (with a maximum of four sub questions) from each module carrying 20 marks each. Students are required to answer any **five full questions** choosing at least **one full question from each module.**

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Continuous Internal Evaluation (CIE): Three Tests are to be conducted for 40 marks each. The average of the three tests are taken for computation of CIE on a scale of 40. CIE is executed by way of two quizzes / Other Assessment Tools (OATs), and three tests.

Some possible AATs:

Assignments/ group activity / any other.

Typical Evaluation pattern for regular courses is shown in Table 2.

Table 2: Distribution of weightage for CIE & SEE of Regular courses

	Component	Marks	Total Marks
CIE	CIE Test-1	**40**	**50**
	CIE Test-2	**40**	
	CIE Test-3	**40**	
	Quiz /OAT	**10**	
SEE	Semester End Examination	**100**	**50**
Grand Total			**100**

CO/PO Mapping															
CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO43.1	3	3	1	-	-	-	-	-	-	-	-	-	2	-	-
CO43.2	2	2	-	-	-	-	-	-	-	-	-	2	2	-	-
CO43.3	2	3	1	-	-	1	-	-	-	-	-	2	2	-	-
CO43.4	2	3	1	-	-	1	-	-	-	-	-	2	2	-	-
CO43.5	2	3	3	2	2	1	1	-	1	-	1	2	2	-	-
Average	**2**	**3**	**2**	**2**	**2**	**1**	**1**	**-**	**1**	**-**	**1**	**2**	**2**	**-**	**-**

Low - 1: Medium - 2: High - 3

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SEMESTER – IV

Course: THEORY OF MACHINES

Course Code	**21MED44**	**CIE Marks**	**50**
Hours/Week (L: T: P)	**3 : 2 : 0**	**SEE Marks**	**50**
No. of Credits	**3**	**Examination Hours**	**03**

Prerequisites: Engineering Mechanics

Course Objectives: This course will enable the students to:

CLO1	Impart knowledge on various types of mechanisms and their inversions.
CLO2	Familiarize with motion transmission elements of spur gear, gear trains and cams.
CLO3	Understand the static force analysis of four bar and Slider-crank mechanisms graphically.
CLO4	Understand the gyroscopic effect on aeroplane, ship, two & four wheel vehicle.
CLO5	Understand the need for balancing of rotating to achieve static & dynamic equilibrium conditions.

Content	No. of Hours/ RBT levels
Module 1 **Fundamentals of Mechanisms**: Kinematic Link & pairs, Classification of kinematic pairs, Constrained motion & its types, Kinematic chain, Mechanism, Degrees of freedom, Mobility of mechanism & Grubbler's criteria. List the Inversions of Four bar chain, Slider crank chain and Double slider crank chain. **Inversion Mechanisms:** Quick return motion mechanisms - Crank and slotted lever Mechanism. Straight-line motion mechanisms: Peaucellier's mechanism. Intermittent Motion mechanisms: Geneva wheel mechanism, Ratchet and Pawl mechanism. Toggle mechanism, Pantograph, Ackerman steering gear mechanism.	**08 Hours / L3**
Module 2 **Gears:** Gear terminology, Law of gearing, path of contact, arc of contact, contact ratio of spur gear. Interference in involute gears, methods of avoiding interference, Expressions for minimum number of teeth to avoid interference (No derivations), Numerical on spur gear. **Gear Trains:** Simple gear trains, Compound gear trains, Reverted gear train, Epicyclic gear trains: Method to find Velocity ratio Or train value - Tabular method. Torque calculation in epicyclic gear trains.	**08 Hours / L3**
Module 3 **Cams:** Classification of cams & followers, Cam nomenclature, Follower motions: Uniform velocity (UV), Uniform acceleration and deceleration (UARM), Simple harmonic motion (SHM), & cycloidal motion. Cam profiles: cam profiles with knife-edge follower & roller follower (Inline & offset).	**08 Hours / L3**

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Module 4 **Static force Analysis:** 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 (Graphical method). **Gyroscope:** Principle of gyroscope, gyroscopic couple. Effect of gyroscopic couple on aeroplane, ship, stability of two wheelers and four wheelers (No derivations for 2 & 4 wheelers), numerical problems.	**08 Hours / L3**
Module 5 **Balancing of Rotating Masses:** Static and dynamic balancing, balancing of single rotating mass by balancing masses in same plane and in different planes. Balancing of several rotating masses by balancing masses in the same plane and in different planes.	**08 Hours / L3**

COURSE OUTCOMES: Upon completion of this course, student will be able to

CO44.1	Analyze the kinematic mechanisms & their inversions for various applications.
CO44.2	Analyze speed and torque in gear trains with knowledge of spur gear terminologies.
CO44.3	Illustrate CAM profiles with an acquaintance of follower motions.
CO44.4	Examine static equilibrium conditions for four-bar & slider-crank mechanisms.
CO44.5	Analyze the gyroscopic effect in the context of stabilization of aeroplane, ship, two & four-wheeler vehicles.
CO44.6	Assess static & dynamic equilibrium conditions for rotating masses.

Textbooks:

1. **Rattan S.S,** Theory of Machines, Tata McGraw-Hill Publishing Company Ltd., New Delhi, 4th Edition, 2014.
2. **Uickers, J J, Pennock G R & Shigley J E,** Theory of Machines & Mechanisms, SI Edition, OXFORD University Press, 3rd Edition 2009.

Reference books:

1. **Sadhu Singh**, Theory of Machines, Pearson Education (Singapore) Pvt Ltd, Indian Branch New Delhi, 2nd Edition 2006.
2. **P. L. Ballaney**, Theory of Machines and Mechanisms, Khanna Publications – 2003.
3. **Thomas Bevan**, Theory of Machines, Pearson Education Ltd., 3rd Edition, 2010.
4. **A. G. Ambekar**, Mechanism and Machine Theory, PHI, 2007.
5. **Dr. R K Bansal, Dr. J S Brar**, Theory of Machines, Laxmi Publications (New Delhi), 5th Edition 2016.

E-Books / Web References

1. Text Book: Robt. F. McKay, The Theory of Machines (https://archive.org/details/theoryofmachines00mckarich)
2. Text Book: Theory of Machines, Sadhu Singh, 3rdEdition. 2011, Pearson, Kindle Edition (http://www.cs.cmu.edu/~rapidproto/mechanisms/tablecontents.html)
3. https://ekeeda.com/degree-courses/mechanical-engineering/theory-of-machines

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MOOCs

1. NPTEL Course: "Kinematics of Machines" (http://nptel.ac.in/courses/112104121/1)
2. NPTEL Course: "Kinematics of Machines" https://nptel.ac.in/courses/112/105/112105268/
3. NPTEL Course : "Dynamics of Machines" https://nptel.ac.in/courses/112/101/112101096/
4. NPTEL Course : "Dynamics of Machines" https://nptel.ac.in/courses/112/104/112104114/

Scheme of Examination: (Theory courses)

Semester End Examination (SEE):

SEE Question paper is to be set for 100 marks and the marks scored will be proportionately reduced to 50. There will be two full questions (with a maximum of four sub questions) from each module carrying 20 marks each. Students are required to answer any **five full questions** choosing at least **one full question from each module.**

Continuous Internal Evaluation (CIE):

Three Tests are to be conducted for 40 marks each. The average of the three tests are taken for computation of CIE on a scale of 40. The assignment/Quiz would be for a total of 10 marks.
CIE is executed by way of two quizzes / Other Assessment Tools (OATs), and three tests.

Some possible AATs: Assignments / Oral presentations / Group activity/Projects

Typical Evaluation pattern for regular courses is shown in Table 2.

Table 2: Distribution of weightage for CIE & SEE of Regular courses

	Component	Marks	Total Marks
CIE	CIE Test-1	**40**	**50**
	CIE Test-2	**40**	
	CIE Test-3	**40**	
	QUIZ/OAT	**10**	
SEE	Semester End Examination	**100**	**50**
		Grand Total	**100**

CO/PO Mapping															
CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO44.1	3	2	2	1		1	1						2		
CO44.2	3	2	2	1		1	1						2		
CO44.3	3	2	2	1		1	1						2		
CO44.4	3	2	2	1		1	1						2		
CO44.5	3	2	2	1		1	1		1	1			2		
CO44.6	3	2	2	1		1	1		1	1			2		
Average	**3**	**2**	**2**	**1**		**1**	**1**		**1**	**1**			**2**		

Low - 1: Medium - 2: High - 3

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SEMESTER – IV

Course: COMPUTER AIDED MODELLING

Course Code	**21MED45**	**CIE Marks**	**50**
Hours/Week (L: T: P)	**2 : 2 : 0**	**SEE Marks**	**50**
No. of Credits	**3**	**Examination Hours**	**03**

Prerequisites: Computer Aided Engineering Drawing.

Course Objectives: This course will enable the students to

CLO1	Acquire the knowledge of basic commands and tools using Solid Edge software and produce drawings using orthographic projections.
CLO2	Draw the 3D part Model from the 2D sketches using Solid edge.
CLO3	Develop Part Models and create assembly using Solid edge.
CLO4	Convert Assembly drawing into 2D drafting and generate Bill of materials for assembled drawing.
CLO5	Create exploded views, rendering using Solid Edge.

Content	No. of Hours/ RBT levels
Module 1 **Sketching: Introduction to Solid Edge Software** 1. 3D Sketching Overview 2. Drawing ordered sketches of parts 3. Drawing commands 4. Sketch geometric relationships 5. Dimensioning sketches 6. Sketches in Path Finder 7. Moving sketches 8. Projecting elements onto a sketch plane **Orthographic Projections:** Introduction to orthographic projection, drawing of simple machine elements in first angle projection. Principle of visualization of objects, sectional views, full and half-sectional views.	**08 Hours / L1, L2, L3**
Module 2 **Part Design:** **1. Constructing base features.** 1. What is base feature? 2. Part modelling 3. Creating base features 4. Model Dimensions 5. Coordinate Systems	**08 Hours / L1, L2, L3**

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2. Moving and rotating faces 1. Part modification by moving and rotating faces and planes 2. Selecting faces **3. Constructing treatment features** 1. Rounding and blending 2. Chamfer command 3. Adding draft to parts 4. Thickening and thinning parts **4. Constructing functional features** 1. Functional features 2. Hole command 3. Pattern features 4. Feature libraries 5. Detaching and attaching faces and features 6. Cutting, copying and pasting model elements 7. Mirror 8. Replace Face command **Introduction to part drawing:** Conversion of 2D drawings in to 3D parts and sectional views of simple machine components (Detailed 2D part drawings will be given).	
Module 3 **Assembly Design:** 1. Solid Edge Assembly 2. More Assembly Relationships 3. The Assemble command 4. Assembly features 5. Assembly patterning 6. Inspecting assemblies 7. Replacing parts in an assembly Limits, fits and tolerances, types of tolerances and fits, hole basis and shaft basis of fits, and geometric dimensioning and tolerance. **Introduction to assembly drawing:** Assembly of simple machine elements like Screw Jack, Machine Vice, Plummer block, Tool post, Tail stock, Socket and spigot Joint, Protected type flanged Coupling etc. (Detailed 2D part drawings will be given).	**08 Hours / L1, L2, L3**
Module 4 **Drafting:** 1. Creating detailed drawings 2. Drawing creation 3. Dimensions, Annotations and Parts Lists 4. Detailing a drawing 5. Bill of Materials **Conversion of Assembled view to 2D drafting.**	**08 Hours / L1, L2, L3**

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Module 5	
The Explode-Render application: 1. Exploding an assembly 2. Rendering - define textures, lighting, shadows, backgrounds and other properties to create presentation style images. **Assign material properties and textures to parts and subassemblies**	**08 Hours / L1, L2, L3**

COURSE OUTCOMES: Upon completion of this course, student will be able to:

CO45.1	Sketch the orthographic views of machine components from a pictorial view.
CO45.2	Develop 3D models of machine parts with the knowledge of Modelling Commands.
CO45.3	Build 3D geometric model of machine assembly by reading the blueprint of each part.
CO45.4	Convert assembled 3D model to 2D drafting, Bill of Materials and of machine components using CAD software.
CO45.5	Represent an Exploded view and rendering Environment.

Textbooks:

1. **K R Gopalakrishna,** Machine Drawing, New Age International Publishers, 6th Edition, 2019.
2. **N. D. Bhatt,** Machine Drawing, Charotar Publication, 50th Edition 2016.

Reference books:

1. **KL Narayana, P Kannaiah, K V Reddy,** Machine Drawing, New Age International Publishers, 6th Edition, 2019.
2. **Sidheshwar,** Machine Drawing, Tata McGraw-Hill Education, 33 reprint 2006.
3. **R.K.Dhawan,** Machine Drawing, S Chand Publishing reprint, 2006.

E-Books / Web References

1. Solid Edge 2021 Part Design Tutorial for Beginner [COMPLETE].
2. https://www.youtube.com/watch?v=pgSHJmObd00
3. Solid Edge fundamentals https://support.industrysoftware.automation.siemens.com/training/se/en/ST4/pdf/mt01413-s-1040_en.pdf.
4. Assembly : https://support.industrysoftware.automation.siemens.com/training/se/en/ST4/pdf/spse01660-s-1040_en.pdf
5. Explode — Render — Animate application : https://d2t1xqejof9utc.cloudfront.net/files/17325/SolidEdge_ERA_2.pdf?1357790407
6. Computer Mouse (Solid Edge Tutorial): https://www.youtube.com/watch?v=0SuN3pVSE_8

Scheme of Examination:

Semester End Examination (SEE):

SEE Question paper is to be set for 100 marks and the marks scored will be proportionately reduced to 50. There will be three full questions. First two module carrying 20 marks each and one full question from the remaining three modules for 60 marks. Students are required to answer any **three full questions choosing at least one full question from each module.**

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Continuous Internal Evaluation (CIE):
Three Tests are to be conducted for 40 marks each. Average of three test is considered and added to assignment component of 10 marks.

Some possible AATs:
Assignments/ oral presentation/ group activity / projects /any other.

Typical Evaluation pattern for regular courses is shown in Table 2.

Table 2: Distribution of weightage for CIE & SEE of Regular courses

	Component	Marks	Total Marks
CIE	CIE Test-1	**40**	**50**
	CIE Test-2	**40**	
	CIE Test-3	**40**	
	Assignment	**10**	
SEE	Semester End Examination	**100**	**50**
Grand Total			**100**

CO/PO Mapping															
CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO45.1	3	3			3			1		3		3	2		
CO45.2	3	3			3			1		3		3	2		
CO45.3	3	3			3			1		3		3	2		
CO45.4	3	2			3			1		3		3	2		
CO45.5	1	1			3			1		3		3	2		
Average	**3**	**3**			**3**			**1**		**3**		**3**	**2**		

Low - 1: Medium - 2: High - 3

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SEMESTER – IV

Course: Samskruthika Kannada

Course Code	21KSK46	CIE Marks	50
Hours/Week (L: T: P)	1 : 0 : 0	SEE Marks	50
No. of Credits	1	Examination Hours	03

ಸಾಂಸ್ಕೃತಿಕ ಕನ್ನಡ ಕಲಿಕೆಯ ಉದ್ದೇಶಗಳು:

- ಪದವಿ ವಿದ್ಯಾರ್ಥಿಗಳಾಗಿರುವುದರಿಂದ ಸಾಂಸ್ಕೃತಿಕ ಕನ್ನಡ ಜೊತೆಗೆ ಕ್ರಿಯಾತ್ಮಕ ಕನ್ನಡವನ್ನು, ಕನ್ನಡ ಸಾಹಿತ್ಯ, ಸಂಸ್ಕೃತಿ ಮತ್ತು ನಾಡು ನುಡಿಯ ಪರಿಚಯ ಮಾಡಿಕೊಡುವುದು.
- ವಿದ್ಯಾರ್ಥಿಗಳಲ್ಲಿ ಕನ್ನಡ ಭಾಷೆಯ ವ್ಯಾಕರಣದ ಬಗ್ಗೆ ಅರಿವು ಮೂಡಿಸುವುದು ಮತ್ತು ಕನ್ನಡ ಭಾಷಾ ರಚನೆಯಲ್ಲಿನ ನಿಯಮಗಳನ್ನು ಪರಿಚಯಿಸುವುದು.
- ಕನ್ನಡ ಭಾಷಾ ಬರಹದಲ್ಲಿ ಕಂಡುಬರುವ ದೋಷಗಳು ಹಾಗೂ ಅವುಗಳ ನಿವಾರಣೆ.
- ಸಾಮಾನ್ಯ ಅರ್ಜಿಗಳು, ಸರ್ಕಾರಿ ಮತ್ತು ಅರೆ ಸರ್ಕಾರಿ ಪತ್ರವ್ಯವಹಾರದ ಬಗ್ಗೆ ಅರಿವು ಮೂಡಿಸುವುದು.
- ಭಾಷಾಂತರ ಮತ್ತು ಪ್ರಬಂಧ ರಚನೆ ಬಗ್ಗೆ ಆಸಕ್ತಿ ಮೂಡಿಸುವುದು.
- ಕನ್ನಡ ಭಾಷಾಭ್ಯಾಸ, ಸಾಮಾನ್ಯ ಕನ್ನಡ ಹಾಗೂ ಆಡಳಿತ ಕನ್ನಡದ ಪದಗಳ ಪರಿಚಯ ಮಾಡಿಕೊಡುವುದು.

ಸಾಂಸ್ಕೃತಿಕ ಕನ್ನಡ ಪಠ್ಯಪುಸ್ತಕ

ಪರಿವಿಡಿ

ಭಾಗ – ಒಂದು ಲೇಖನಗಳು (ಕನ್ನಡ ನಾಡು, ನುಡಿ ಮತ್ತು ಸಂಸ್ಕೃತಿಗೆ ಸಂಬಂಧಿಸಿದ ಲೇಖನಗಳು)

೧. ಕರ್ನಾಟಕ ಸಂಸ್ಕೃತಿಗೆ : ಹಂಪ ನಾಗರಾಜಯ್ಯ

೨. ಕರ್ನಾಟಕದ ಏಕೀಕರಣ : ಒಂದು ಅಪೂರ್ವ ಚರಿತ್ರೆ – ಜಿ. ವೆಂಕಟಸುಬ್ಬಯ್ಯ

೩. ಆಡಳಿತ ಭಾಷೆಯಾಗಿ ಕನ್ನಡ – ವಿತಾವಿಯ ಆಡಳಿತ ಕನ್ನಡ ಪುಸ್ತಕದಿಂದ ಆಯ್ದ ಲೇಖನ*

ಭಾಗ – ಎರಡು ಕಾವ್ಯ ಭಾಗ (ಆಧುನಿಕ ಪೂರ್ವ)

೪. ವಚನಗಳು : ಬಸವಣ್ಣ, ಅಕ್ಕಮಹಾದೇವಿ, ಅಲ್ಲಮಪ್ರಭು, ಆಯ್ದಕ್ಕಿ ಮಾರಯ್ಯ, ಜೇಡರ ದಾಸಿಮಯ್ಯ, ಆಯ್ದಕ್ಕಿ ಲಕ್ಕಮ್ಮ

೫. ಕೀರ್ತನೆಗಳು : ಅದರಿಂದೇನು ಫಲ ಇದರಿಂದೇನು ಫಲ – ಪುರಂದರದಾಸ

ತಲ್ಲಣಿಸದಿರು ಕಂಡ್ಯತಾಳು ಮನವೆ – ಕನಕದಾಸ

೬. ತತ್ವಪದಗಳು : ಸಾವಿರ ಕೊಡಗಳ ಸುಟ್ಟು – ಶಿಶುನಾಳ ಷರೀಫ

ಶಿವಯೋಗಿ – ಬಾಲಲೀಲಾ ಮಹಾಂತ ಶಿವಯೋಗಿ

೭. ಜನಪದ ಗೀತೆ : ಬೀಸುವ ಪದ, ಬಡವರಿಗೆ ಸಾವ ಕೊಡಬೇಡ

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ಭಾಗ – ಮೂರು ಕಾವ್ಯ ಭಾಗ (ಆಧುನಿಕ)

೮. ಮಂಕುತಿಮ್ಮನ ಕಗ್ಗ : ಡಿ.ವಿ.ಜಿ.

೯. ಕುರುಡು ಕಾಂಚಾಣಾ : ದ.ರಾ. ಬೇಂದ್ರೆ

೧೦. ಹೊಸಬಾಳಿನ ಗೀತೆ : ಕುವೆಂಪು

೧೧. ಹೆಂಡತಿಯ ಕಾಗದ : ಕೆ.ಎಸ್. ನರಸಿಂಹಸ್ವಾಮಿ

೧೨. ಮಬ್ಬಿನಿಂದ ಮಬ್ಬಿಗೆ : ಜಿ.ಎಸ್. ಶಿವರುದ್ರಪ್ಪ

೧೩. ಆ ಮರ ಈ ಮರ : ಚಂದ್ರಶೇಖರ ಕಂಬಾರ

೧೪. ಚೋಮನ ಮಕ್ಕಳ ಹಾಡು : ಸಿದ್ಧಲಿಂಗಯ್ಯ

ಭಾಗ – ನಾಲ್ಕು ತಾಂತ್ರಿಕ ವ್ಯಕ್ತಿ ಪರಿಚಯ, ಕಥೆ ಮತ್ತು ಪ್ರವಾಸ ಕಥನ

೧೫. ಡಾ. ಸರ್ ಎಂ. ವಿಶ್ವೇಶ್ವರಯ್ಯ – ವ್ಯಕ್ತಿ ಮತ್ತು ಐತಿಹ್ಯ : ಎ ಎನ್ ಮೂರ್ತಿರಾವ್

೧೬. ಯುಗಾದಿ : ವಸುಧೇಂದ್ರ

೧೭. ಮೆಗಾನೆ ಎಂಬ ಗಿರಿಜನ ಪರ್ವತ : ಹಿ.ಚಿ.ಬೋರಲಿಂಗಯ್ಯ

ಭಾಗ – ಐದು ವಿಜ್ಞಾನ ಮತ್ತು ತಂತ್ರಜ್ಞಾನ

೧೮. ಕರಕುಶಲ ಕಲೆಗಳು ಮತ್ತು ಪರಂಪರೆಯ ವಿಜ್ಞಾನ : ಕರೀಗೌಡ ಬೀಚನಹಳ್ಳಿ

೧೯. "ಕ" ಮತ್ತು "ಬ" ಬರಹ ತಂತ್ರಾಂಶಗಳು ಮತ್ತು ಕನ್ನಡದ ಟೈಪಿಂಗ್*

೨೦. ಕನ್ನಡ – ಕಂಪ್ಯೂಟರ್ ಶಬ್ದಕೋಶ*

೨೧. ತಾಂತ್ರಿಕ ಪದಕೋಶ : ತಾಂತ್ರಿಕ ಹಾಗೂ ಪಾರಿಭಾಷಿಕ ಕನ್ನಡ ಪದಗಳು*

*(ವಿತಾವಿ ಯ ಆಡಳಿತ ಕನ್ನಡ ಪುಸ್ತಕದಿಂದ ಆಯ್ದ ಲೇಖನಗಳು – ಡಾ. ಎಲ್. ತಿಮ್ಮೇಶ ಮತ್ತು ಪ್ರೋ.ವಿ.ಕೇಶವಮೂರ್ತಿ)

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SEMESTER – IV

Course: Balake Kannada (for Non-Kannadiga Students)

Course Code	21KBK46	CIE Marks	50
Hours/Week (L: T: P)	1 : 0 : 0	SEE Marks	50
No. of Credits	1	Examination Hours	03

Course Learning Objectives:

The course will enable the students to understand Kannada and communicate (converse) in Kannada language.

Table of Contents

- Abbreviations
- Key to Transcription
- Easy learning of a Kannada Language: A few tips
- Necessity of learning a local langauge:
- Tips to learn the language with easy methods.
- Hints for correct and polite conservation
- About Kannada Language (Kannada Bhashe)
- Eight Kannada authors who have won 'Jnanpith Award'
- Information about Karnataka State

Part : I

Instructions to Teachers

1. How to Teach the BaLake Kannada Book
2. Methods to be followed in Teaching of all the chapters/ concepts

Chapter – 1 Listening and Speaking - KelisikoLLuvudu mattu Maatanaduvudu

1. Pronouns – SarvanaamagaLu
2. Adjectives – Naama VisheshaNagaLu
3. Verbs – KriyapadagaLu
4. Adverbs – KriyavisheshaNagaLu

Necessity of learning a local langauge:

The learning of local language,

- Encourages the respect for other people: it fosters an understanding of the interrelation of language and human nature.
- Expands one's view of the world, liberalizes one's experiences, and makes one more flexible and tolerant.
- Limits the barriers between people: barriers cause distrust and fear.
- Opens the door to art, music, dance, fashion, cuisine, film, philosophy, science...etc.
- Leads to an appreciation of cultural diversity.
- Helps fluent communication.

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Language learning helps to develop strong cognitive skills, such as a better concept formation, mental flexibility, multitasking, listening skills and problem-solving, in addition to improve social interaction and also encourages the connection between peers.

Use of local language help to mingle with the local society and ensures security, pleasant welcoming from auto/cab drivers, shop owners, employees of local government etc., and make the living easier and more comfortable.

Tips to learn the language with easy methods.

Apart from the conventional method of learning from teachers, the learning of language can be accelerated by adopting the following methods.

1. Love the learning without boredom.
2. Talk to classmates and others in Kannada without hesitation and with no concern to grammatical mistakes during the initial stages of learning the language.
3. Use English words to continue the conversation when you find difficulty in finding suitable Kannada word/s. Vocabulary improves with the use of language.
4. While reading, read aloud (not silently or in a whisper manner, but audibly so that others are not being disturbed or others can hear what is being read). Reading aloud not only helps proper/ correct pronunciation of words with variation in pitch, pace, volume, pauses etc., but also produces a fluent and enjoyable delivery during conversation/debate/presentation.
5. Listen to Kannada news and watch Kannada movies.
6. Listen to Kannada FM radios for news, live conversations and songs.
7. Use online applications (apps) for fast learning.

Easy learning of a Kannada Language: A few tips

1. Watching Kannada movies (preferably with subtitles), can be of great help. This is an important and entertaining way to improve your language skills.
2. Do not hesitate. Speak the language at every possible opportunity.
3. Never mind if you are using less Kannada and more English words. Kanglish is anyway popular in Bangalore. However constantly try to improve your Kannada vocabulary.
4. Watch Kannada news. This is not only helpful in learning the language, but will help you to know your city better.
5. If you are a user of public transport, carefully listen to co-passengers' conversations.
6. Enjoy the local tang of the language by listening to Kannada FM stations.
7. Do not completely rely on 'Learn Kannada in 30 days' type of books. Many Bangaloreans will fail to comprehend your textbook language and you are sure to face some embarrassment, if you go strictly by books.

Hints for correct and polite conservation

1. Be vigilant about the verbs, the pronouns, the genders and tense required for day to day Conversation.
2. Pronounce the words properly.
3. Use plural form to address others.
4. Use simple sentences for conversation.

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About Kannada Language (Kannada Bhashe)

- Kannada is one of the classical (Shastreeya) languages of India since November 01, 2008, and is the official language of the Karnataka state.
- This language is not just confined within the borders of Karnataka, for you will find it spoken by people in parts of the neighboring states of Andhra Pradesh, Tamil Nadu and Maharashtra. Kannada is spoken in its various dialects by Six to Seven million people across the globe. It is one among the top 40 most spoken languages of the world.
- Spoken Kannada is in use since 2500 years, and has its own script since 1900 years. Spoken Kannada varies according to the regions of Karnataka, while the written form of Kannada remains almost the same. Kannada is the third oldest language of India (after Sanskrit and Tamil).
- The written form of Kannada is phonetic and it is written as it is spoken.
- The first Kannada-English Dictionary (ShabdaKosha) was compiled in 1894 by a German priest, Rev. Ferdinand Kittel. He also wrote a book on Kannada Grammar entitled, "A Grammar of the Kannada Language: Comprising the Three Dialects of the Language".
- Several noted centuries old literary works of Kannada have been translated into Sanskrit, and other languages.
- November 1st of every year is celebrated as Kannada Rajyotsava Day throughout Karnataka state and is declared as a state holiday. This was the day that the name Karnataka was given to the Mysore state in the year 1973.

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SEMESTER – IV

Course: Constitution of India and Professional Ethics

Course Code	21CPH46	CIE Marks	50
Hours/Week (L: T: P)	1 : 0 : 0	SEE Marks	50
No. of Credits	1	Examination Hours	03

Course Objectives:

CLO1	Know the fundamental political codes, structure, procedures, powers, and duties of Indian government institutions, fundamental rights, directive principles, and the duties of citizens.
CLO2	Understand engineering ethics and their responsibilities; identify their individual roles and ethical responsibilities towards society.
CLO3	Know about the cybercrimes and cyber laws for cyber safety measures.

Content	No. of Hours
Module 1 Introduction to Indian Constitution: The Necessity of the Constitution, The Societies before and after the Constitution adoption. Introduction to the Indian constitution, The Making of the Constitution, The Role of the Constituent Assembly - Preamble and Salient features of the Constitution of India. Fundamental Rights and its Restriction and limitations in different Complex Situations. Directive Principles of State Policy (DPSP) and its present relevance in our society with examples. Fundamental Duties and its Scope and significance in Nation building.	**03 Hours**
Module 2 Union Executive and State Executive: Parliamentary System, Federal System, Centre-State Relations. Union Executive – President, Prime Minister, Union Cabinet, Parliament - LS and RS, Parliamentary Committees, Important Parliamentary Terminologies. Supreme Court of India, Judicial Reviews and Judicial Activism. State Executives – Governor, Chief Minister, State Cabinet, State Legislature, High Court and Subordinate Courts, Special Provisions (Articles 370.371,371J) for some States.	**03 Hours**
Module 3 Elections, Amendments and Emergency Provisions: Elections, Electoral Process, and Election Commission of India, Election Laws. Amendments - Methods in Constitutional Amendments (How and Why) and Important Constitutional Amendments. Amendments – 7, 9, 10, 12, 42, 44, 61, 73, 74, 75, 86 and 91, 94, 95, 100, 101, 118 and some important Case Studies. Emergency Provisions, types of Emergencies and its consequences. Constitutional special provisions: Special Provisions for SC and ST, OBC, Women, Children and Backward Classes.	**03 Hours**
Module 4 Professional / Engineering Ethics: Scope & Aims of Engineering & Professional Ethics - Business Ethics, Corporate Ethics, Personal Ethics. Engineering and Professionalism, Positive and Negative Faces of Engineering Ethics, Code of Ethics as defined in the website of Institution of Engineers (India): Profession, Professionalism, and Professional Responsibility. Clash of Ethics, Conflicts of Interest. Responsibilities in Engineering Responsibilities in Engineering and	**03 Hours**

Engineering Standards, the impediments to Responsibility. Trust and Reliability in Engineering, IPRs (Intellectual Property Rights), Risks, Safety and liability in Engineering.	
Module 5 Internet Laws, Cyber Crimes and Cyber Laws: Internet and Need for Cyber Laws, Modes of Regulation of Internet, Types of cyber terror capability, Net neutrality, Types of Cyber Crimes, India and cyber law, Cyber Crimes and the information Technology Act 2000, Internet Censorship. Cybercrimes and enforcement agencies.	**03 Hours**

COURSE OUTCOMES: Upon completion of this course, student will be able to

CO46.1	Have constitutional knowledge and legal literacy.
CO46.2	Understand Engineering and Professional ethics and responsibilities of Engineers.
CO46.3	Understand the cybercrimes and cyber laws for cyber safety measures.

TEXTBOOKS:

1. Constitution of India, Professional Ethics and Human, O Shubham Singles, Charles E. Haries, and et. al., Cengage Learning India, 2018.
2. Cyber Security and Cyber Laws, Alfred Basta and et. al., Cengage Learning India, 2018.

REFERENCE BOOKS:

1. Introduction to the Constitution of India, Durga Das Basu, Prentice –Hall, 2008.
2. Engineering Ethics, M. Govindarajan, S. Natarajan, V. S. Senthilkumar, Prentice –Hall, 2004.

Scheme of Examination:

There is no Semester End Examination for this course. The assessment is based on Continuous Internal Evaluation only.

Continuous Internal Evaluation (CIE):

Three Tests are to be conducted for 40 marks each. The average of the three tests are taken for computation of CIE. The assignment/Quiz/ Alternate Assessment Tools would be for a total of 10 marks**.** All quizzes are conducted online. Faculty may adopt innovative methods for conducting quizzes effectively. Typical Evaluation pattern for this course is shown in Table 2.

Table 2: Distribution of weightage for CIE

	Component	Marks	Total Marks
CIE	CIE Test-1	**40**	**50**
	CIE Test-2	**40**	
	CIE Test-3	**40**	
	Quiz 1/AAT	**10**	
	Quiz 2/AAT	**10**	
SEE	Semester End Examination	**100**	**50**
		Grand Total	**100**

CO/PO Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO46.1																
CO46.2																
CO46.3																

Low - 1: Medium - 2: High – 3

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SEMESTER – IV

Course: Ability Enhancement Course – II: Automotive Engines, GD & T

Subject Code	21MED47	CIE Marks	50
Hours/Week (L: T: P)	0 : 0 : 2	SEE Marks	50
Credits	01	Examination Hours	03

Course Objectives: This course will enable the students to

CLO1	Impart students to the fundamental knowledge of automobile technology.
CLO2	Use critical thinking skills in developing part drawings from solid models
CLO3	Understand the importance of Geometric Dimensioning & Tolerancing

Content	No. of Hours/ RBT levels
Module 1 Parts of an Automobile, Assembly and disassembly of automotive parts (Hands-on Session), Transmission system, Measure the dimensions and develop basic part drawings of Automotive parts.	**06 Hours / L3**
Module 2 The basic concepts of Geometric Dimensioning and tolerancing, apply GD&T to a part drawing.	**06 Hours / L3**

COURSE OUTCOMES: Upon completion of this course, student will be able to

CO47.1	Perform assembly and disassembly operations on a transmission system
CO47.2	Develop part drawings for Automotive parts.
CO47.3	Apply GD&T to part drawings

TEXTBOOKS:

1. Ashok Kumar, Simplified GD&T: Based on ASME-Y 14.5-2009, second edition, Independent publishers, second edition, 2019Avikshit Saras, 3D Printing Made Simple, BPB Publications, 2019
2. R. P Sharma, A Course in Automobile Engineering, Dhanpat Rai Publications, 2013

CO/PO Mapping															
CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO47.1	2	-	-	-	-	2	2	2	2	-	-	2	3	-	-
CO47.2	2	2	-	-	3	2	2	2	-	2	-	2	3	-	-
CO47.3	2	-	-	-	-	2	2	2	-	2	-	2	3	-	-
Average	**2**	**2**	**-**	**-**	**3**	**2**	2	2	**2**	**2**	**-**	**2**	**3**	**-**	**-**

Low - 1: Medium - 2: High – 3

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SEMESTER – IV

Course: Inter/Intra Institutional Internship

Subject Code	21INT48	CIE Marks	100
Hours/Week (L: T: P)	0 : 0 : 3	SEE Marks	-
Credits	02	Examination Hours	-

Course Objectives: The students will be taught:

CLO1	The technical skills required to enhance their knowledge in the field of mechanical engineering.
CLO2	The recent advances in mechanical engineering through industrial visits and guest lectures.
CLO3	The skills required to broaden their chances for landing a job and jump-starting their careers.
CLO4	The soft skills to imbibe professionalism in their work environment

Internship:
All the students admitted to II year of BE/B. Tech must undergo mandatory internship of 2 weeks between III and IV semesters and the prescribed credit shall be included in IV semester. Internship will be considered for the award of Bachelor's degree. Those, who do not take-up/complete the internship shall be declared fail and shall have to complete during subsequent University examination after satisfying the internship requirements.

CIE procedure for Internship:
The CIE marks shall be awarded by a committee consisting of the Head of the concerned Department and two senior faculty members of the Department, one of whom shall be the Guide.
The CIE marks awarded for the Internship shall be based on attendance, assessments and the evaluation of Internship report, presentation skill in the ratio **30:40:30**.

CO/PO Mapping															
CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
	3	3	2	2	1	1	1	1	1	1	1	1	-	-	-

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SEMESTER – IV

Course: MACHINE SHOP

Subject Code	**21MEDL49**	**CIE Marks**	**50**
Hours/Week (L: T: P)	**0 : 0 : 1**	**SEE Marks**	**50**
Credits	**01**	**Examination Hours**	**03**

Course Objectives: This course will enable the students to

CLO1	Guide students to use fitting tools to perform fitting operations.
CLO2	Provide an insight to different machine tools, accessories, and attachments.
CLO3	Train students into machining operations to enrich their practical skills.
CLO4	Inculcate team qualities and expose students to shop floor activities.

Sl. No.	Experiments	No. of Hours/ RBT levels
	Part- A	
1	Introduction to lab and safety measures, study the constructional features of Lathe, Milling, Drilling and Shaping machines with the help of sketches and diagrams, role of machining in industries. Preparation of at least two fitting models by proficient handling and application of hand tools.	**06 Hours / L3**
	Part - B	
1	**Lathe work** – Production of composite job, which includes facing, turning, step turning, taper turning, threading, knurling, drilling and boring. (Selection of cutting parameters and machining time calculation)	**06 Hours / L3**
2	**Milling machine** – Usage of milling cutters to understand plain milling and end milling. Produce T-slots, cutting of gear teeth.	**04 Hours / L3**
3	**Drilling machine** – Produce simple holes and carry out operations such as boring and threading.	**02 Hours / L3**
4	**Shaping machine** – Cutting of V-groove/ Rectangular/ Dovetail groove	**04 Hours / L3**
	Part – C	
1	Demonstration of surface grinding on flat surfaces	**01 Hours / L3**
2	Demonstration of power hacksaw	**01 Hours / L3**
3	Demonstration of CNC lathe and milling machine	**02 Hours / L3**

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Course Outcomes: Upon successful completion of this course, student will be able to

CO1	Interpret the working mechanisms of conventional machine tools.
CO2	Choose the required hand tools and cutting tools for the material removal process.
CO3	Prepare fitting models according to given drawing using hand tools.
CO4	Produce components to a given specification using different operations on a lathe machine.
CO5	Produce components with gear teeth, slots, grooves, and holes to a given specification using milling, shaping, and drilling machines.

Textbooks:

1. **P N Rao**, Manufacturing Technology Vol I & II, 5th Edition
2. **Sharma P C**, A textbook of Production Technology Vol I and II, S Chand and Company Ltd., New Delhi.

References:

1. **Chapman W A,** Workshop technology Vol I & Vol II
2. **Hajra Choudhary S K and Hajra Choudhary A K,** Elements of Manufacturing technology Vol II

Website references:

1. https://nptel.ac.in/courses/112/105/112105233/
2. http://vlabs.iitb.ac.in/vlabs-dev/labs/mit_bootcamp/machine_tools/labs/index.php

Scheme of Examination:

Semester End Examination (SEE):

One model using Lathe machine	**40 Marks**
One model using Milling / Shaping / Drilling	**40 Marks**
Viva Voce	**20 Marks**

Note: SEE will be conducted for 100 Marks and reduced to 50

Continuous Internal Evaluation (CIE):

Weekly performance - Lab participation + Report	**30 Marks**
One Internal Assessment at the end of semester	**20 Marks**

CO/PO Mapping															
CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO49.1	3	3	2			1	1	1	3	1		2			3
CO49.2	3	3	2			1	1	1	3	1		2			3
CO49.3	3	3	2			1	1	1	3	1		2			3
CO49.4	3	3	2			1	1	1	3	1		2			3
CO49.5	3	3	2			1	1	1	3	1		2			3
Average	3	3	2			1	1	1	3	1		2			3

Low - 1: Medium - 2: High – 3

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V - VI SEMESTER
SCHEME AND SYLLABUS
Department of
MECHANICAL ENGINEERING

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(Autonomous Institution Affiliated to VTU)
Scheme of UG Autonomous Program – 2021 Batch

V SEMESTER

Sl. No.	Course Code	Course Title	Course Type	Teaching Dept.	Teaching Hours/Week			Examination			CREDITS
					L	T	P	CIE	SEE	Total	
1	21MED51	Management & Economics	PC	Respective Department	3	0	0	50	50	100	3
2	21MED52	Fluid Mechanics & Machinery (Integrated)	IPC		3	0	2	50	50	100	4
3	21MED53	Design of Machine Elements	PC		2	2	0	50	50	100	3
4	21MED54X	Program Elective 1	PEC		3	0	0	50	50	100	3
5	21MED55	Research Methodology	AEC		3	0	0	50	50	100	3
6	21MED56	Ability Enhancement Course - III: Automation Through Hydraulics & Pneumatics.	AEC		0	0	2	50	50	100	1
7	21CIV57/67	Environmental Science	HSM	Civil	1	0	0	50	50	100	1
	OR										
	21UHV57/67	Universal Human Values	HSM	Any Department							
8	21MEDL58	Fuel and Engine Testing Laboratory	PC	Respective Department	0	0	2	50	50	100	1
				TOTAL				**400**	**400**	**800**	**19**

VI SEMESTER

Sl. No.	Course Code	Course Title	Course Type	Teaching Dept.	Teaching Hours/Week			Examination			CREDITS
					L	T	P	CIE	SEE	Total	
1	21MED61	Industrial Robotics	PC	Respective Department	3	0	0	50	50	100	3
2	21MED62	Heat Transfer (Integrated)	IPC		3	0	2	50	50	100	4
3	21MED63	Finite Element Methods (Integrated)	IPC		3	0	2	50	50	100	4
4	21MED64X	Program Elective 2	PEC		3	0	0	50	50	100	3
5	21MED65X	Open Elective 1	OEC	Respective Offering Department	3	0	0	50	50	100	3
6	21MED66	Ability Enhancement Course – IV: CNC Technology.	AEC	Respective Department	0	0	2	50	50	100	1
7	21CIV57/67	Environmental Science	HSM	Civil	1	0	0	50	50	100	1
	OR										
	21UHV57/67	Universal Human Values	HSM	Any Department							
8	21MEDP68	Mini Project	MP	Respective Department	Two Contact hours per week			50	50	100	2
				TOTAL				**400**	**400**	**800**	**21**

Program Elective & Open Elective

Program Elective - 1		
Sl. No.	**Course Code**	**Course Title**
1	21MED541	Design for Manufacturing & Assembly
2	21MED542	Energy, Environment and Sustainable Development
3	21MED543	Additive Manufacturing
4	21MED544	Product Life Cycle Management
Program Elective - 2		
Sl. No.	**Course Code**	**Course Title**
1	21MED641	Mechanical Vibrations & Condition Monitoring
2	21MED642	Automotive Engineering and Hybrid Vehicle Technology
3	21MED643	Design of Transmission Elements
4	21MED644	Data Analytics

Open Elective - 1		
Sl. No.	**Course Code**	**Course Title**
1	21MED651	Project & Operations Management
2	21MED652	Quantitative Techniques

V SEMESTER

SYLLABUS

SEMESTER –V

Course: Management & Economics

Course Code	21MED51	CIE Marks	50
Hours/Week (L: T: P)	3 : 0 : 0	SEE Marks	50
No. of Credits	3	Examination Hours	03

Prerequisites: NiL

Course Objectives: To provide an insight to**,**

CLO1	Understand needs, functions, roles, scope and evolution of Management.
CLO2	Discuss Decision making, Organizing, Staffing, Directing and Controlling.
CLO3	Describe the understanding of motivation and different control system in Management.
CLO4	Understand various interest rate methods and implement the suitable one.
CLO5	Select the best economic model from various available alternatives.
CLO6	Estimate various depreciation values of commodities.

Content	No. of Hours/ RBT levels
Module 1 **Management: Introduction** - Meaning - nature and characteristics of Management, Scope and Functional areas of management - Management as a science, art of profession - Management & Administration - Roles of Management, Levels of Management. **Planning:** Nature, importance and purpose of planning process, Objectives - Types of plans (Meaning Only) - Decision making Importance of planning - steps in planning & planning premises - Hierarchy of plans.	**08 Hrs. / L1,L2,L3**
Module 2 **Organizing and Staffing:** Nature and purpose of organization Principles of organization - Types of organization - Depart mentation Committees Centralization Vs Decentralization of authority and responsibility. Nature and importance of staffing--Process of Selection & Recruitment (in brief). **Directing & Controlling**: Meaning and nature of directing Leadership styles, Motivation Theories, Communication - Meaning and importance - coordination, meaning and importance and Techniques of Co Ordination. Meaning and steps in controlling - Essentials of a sound control system.	**08 Hrs. / L1,L2,L3**
Module 3 **Introduction:** Engineering and economics, Problem solving and decision making, Laws of demand and supply, Difference between Microeconomics & Macroeconomics, equilibrium between demand & supply, elasticity of demand, price elasticity, income elasticity. Law of Returns. Interest and interest factors, simple and compound interest, Cash flow diagrams, personal loans and EMI payment calculation with flexible interest rates, Discussion and problems.	**08 Hrs. / L1,L2,L3**

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Module 4 **Present, future and annual worth and rate of returns:** Basic present worth comparisons, Present worth equivalence, Assets with unequal lives and infinites lives, future worth comparisons, payback comparisons. Equivalent annual worth comparisons, situations for annual worth comparisons. Asset life, Rate of return, minimum acceptable rate of return, IRR anomalies and misconceptions, Cost of capital, comparisons of all present future and annual worth with IRR, product costing, Discussions and problems.	**08 Hrs. / L1,L2,L3**
Module 5 **Costing and depreciation:** Components of costs, estimation of selling price, marginal cost, first cost, all kinds of overheads, indirect cost estimation with depreciation, mensuration and estimation of material cost, cost estimation of mechanical process, idling time. Causes of depreciation, methods of computing depreciation charges, straight line method, declining balance method, sum of years method, sinking fund method, and service output methods.	**08 Hrs. / L1,L2,L3**

COURSE OUTCOMES: Upon completion of this course, student will be able to:

CO51.1	**Explain** the development of management and the role it plays at different levels in an organization.
CO51.2	**Select** the process and role of effective planning, organizing and staffing for the development of an organization.
CO51.3	**Implement** good leadership, communication and coordination for establishing effective control in an organization.
CO51.4	**Understand** engineering economics demand supply and its importance in economic decision making and problem solving.
CO51.5	**Calculate** present worth, annual worth and IRR for different alternatives in economic decision making.
CO51.6	**Understand** the procedure involved in estimation of Cost for a simple component, Product costing and depreciation, its methods.

Textbooks:

1. Principles of Management – P.C. Tripathi, P.N. Reddy; Tata McGraw Hill, 5th Edition 2012.
2. Engineering Economy Riggs J.L McGraw Hill 4th edition.

Reference books:

3. Mechanical estimation T.R. Banga& S.C. Sharma Khanna Publishers 17th edition 2015
4. Engineering Economy Thuesen H.G PHI 2002
5. Management and Entrepreneurship – N.V.R. Naidu & T. Krishna Rao, I.K. International, New Delhi – 2008
6. Engineering Economy Thuesen H.G PHI 2002

E-Books / Web References

1. https://www.youtube.com/watch?v=vOykcERGw9Y- Principles of management
2. https://drive.google.com/file/d/1O871eMrnRA84N2d2dmRKA5Rtel4QdJ6y/view - Engineering Economics -R. Panneerselvam

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MOOCs

1. https://nptel.ac.in/courses/110105075 - Foundation Course in Managerial Economics
2. https://nptel.ac.in/courses/122106031- Management Concepts

Scheme of Examination:

Semester End Examination (SEE):

SEE Question paper is to be set for 100 marks and the marks scored will be proportionately reduced to 50. There will be two full questions (with a maximum of four sub questions) from each modulecarrying 20 marks each. Students are required to answer any **five full questions** choosing at least **one full questionfrom each module.**

Continuous Internal Evaluation (CIE):

Three Tests are to be conducted for 40 marks each. Average of three tests is taken. CIE is executed by way of one quiz / Alternate Assessment Tools (AATs), and average of three tests. One quiz is to be conducted and evaluated for 10 marks

Some possible AATs:

Assignments/ group activity / any other.

Typical Evaluation pattern for regular courses is shown in Table 2.

Table 2: Distribution of weightage for CIE & SEE of Regular courses

	Component	Marks	Total Marks
CIE	CIE Test-1	**40**	**50**
	CIE Test-2	**40**	
	CIE Test-3	**40**	
	AAT/Quiz	**10**	
SEE	Semester End Examination	**50**	**50**
Grand Total			**100**

CO/PO Mapping															
CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO51.1	2	-	-	-	-	-	-	-	-	-	3	1	-	-	3
CO51.2	3	-	-	-	-	-	-	2	-	-	3	1	-	-	3
CO51.3	2	-	-	-	-	-	-	1	1	1	3	1	-	-	3
CO51.4	3	-	-	-	-	-	-	-	-	-	3	1	-	-	3
CO51.5	3	2	-	-	-	-	-	-	-	-	3	1	-	-	3
CO51.6	2	1	-	-	-	-	-	-	-	-	3	1	-	-	3
Average	**3**	**2**	**-**	**-**	**-**	**-**	**-**	**2**	**1**	**1**	**3**	**1**	**-**	**-**	**3**

Low - 1: Medium - 2: High – 3

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SEMESTER – V

Course: FLUID MECHANICS AND MACHINERY (Integrated)

Course Code	**21MED52**	**CIE Marks (Theory + Lab)**	**30 + 20 = 50**
Hours/Week (L: T: P)	**3 : 0 : 2**	**SEE Marks**	**50**
No. of Credits	**4**	**Examination Hours**	**03**

Prerequisites: Fluid Mechanics, Physics, Basics of Mathematical concepts learnt in the 1st year of Mathematics.

Course Objectives: To enable students to apply the knowledge of fluid machinery in broad domain of mechanical engineering and henceforth they will be taught:

CLO1	The basics of fluid properties and measurement of pressure
CLO2	Working of a turbomachine and its correlation to Thermodynamics
CLO3	Working Principle, Model studies of Hydraulic Turbines
CLO4	Working Principle, Model studies of Steam Turbines
CLO5	Principle or working, slip and cavitation in Centrifugal and reciprocating Pumps

Content	**No. of Hours/ RBT levels**
Module 1 **Basics:** Introduction, types of fluid, - viscosity, surface tension, capillarity, vapour pressure & cavitation, Numerical problems. (No derivations). **Fluid Kinematics:** Introduction, methods of describing fluid motion – Rate of flow, continuity equation in Cartesian 2D and 3D coordinates, velocity and acceleration in fluid motion, Velocity potential function and stream function, Equipotential line, line of constant stream function, Relation between stream function and velocity potential function, Numerical problems (No derivations).	**8 Hours / L3**
Module 2 **Fluid Dynamics:** Introduction, equations of motion, Euler's equation of motion, Bernoulli's equation from Euler's equation, Assumptions, Navier Stokes Equation, Bernoulli's equation for real fluid, Applications of Bernoulli's equation (Venturimeter, Orifice meter, pitot tube) Numerical problems. No Derivations. **Introduction and Basics:** Definition of turbo machine, parts of turbo machines, Comparison with positive displacement machines, Classification of turbomachines. Euler's turbine equation, Alternate form of Euler's turbine equation, Velocity triangles – Principle and Types Numerical Problems. (No derivations). ***Laboratory Exercise:*** *Experiment I, II, III, IV*	**8 Hours L3**
Module 3 **Hydraulic Turbines**: Classification, various efficiencies. Pelton Wheel – Principle of working, velocity triangles, design parameters, maximum efficiency, and numerical problems. Francis turbine – Principle of working, velocity triangles, design parameters, and numerical problems.	**8 Hours / L3**

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Kaplan and Propeller turbines - Principle of working, velocity triangles, design parameters and Numerical Problems. Theory and types of Draft tubes. (No Derivations) Concepts of Specific Speed and Model Studies, (No Derivations) ***Laboratory Exercise:*** *Experiment V, VI and VII*	
Module 4 **Steam Turbines**: Classification, Single stage impulse turbine, condition for maximum blade efficiency, stage efficiency, Need and methods of compounding, Multi-stage impulse turbine, expression for maximum utilization factor, Numerical Problems. Reaction turbine – Parsons's turbine, condition for maximum utilization factor, reaction staging. Numerical Problems Concepts of Specific Speed and Model Studies, (No Derivations)	**8 Hours / L3**
Module 5 **Centrifugal Pumps**: Classification and parts of centrifugal pump, different heads and efficiencies of centrifugal pump, Theoretical head – capacity relationship, Minimum speed for starting the flow, Problems, (No Derivations). **Reciprocating Pumps**: Classification and parts of centrifugal pump, Working, Discharge, Work done by a single stage pump, double stage pump, Slip of a reciprocating pump, Numerical Problems, (No Derivations) ***Laboratory Exercise:*** *Experiment VIII, IX and X*	**8 Hours / L3**

COURSE OUTCOMES: Upon completion of this course, student will be able to:

CO52.1	Evaluate the properties of fluids and analyze the mechanics of fluids at rest to solve complex engineering problems.
CO52.2	Synthesize and integrate the basic principles and equations of fluid mechanics and turbomachines to design and optimize fluid systems.
CO52.3	Formulate and implement advanced applications of Euler's equation to enhance the performance and efficiency of hydraulic turbines.
CO52.4	Critically assess and correlate the principles of steam turbines with specific speed and model studies to innovate and improve turbine designs.
CO52.5	Design and evaluate centrifugal and reciprocating pump systems based on an in-depth understanding of their working principles to address complex fluid transport challenges.

Laboratory:

Exercise Number	Experiment	No. of Hours/ RBT Levels
I, II, III, IV	Calibration of flow measuring devices – Orifice Meter, Nozzles, Venturimeter and V- Notch	04 Hours/ L3
V, VI, VII	Performance on hydraulic Turbines-Pelton wheel, Francis Turbine and Kaplan Turbines	02 Hours/ L3
VIII, IX and X	Performance hydraulic Pumps a. Single stage and multistage centrifugal pumps b. Reciprocating pump	04 Hours/ L3

Textbooks:

1. Dr R K Bansal, Fluid Mechanics: Lakshmi Publication 10th Edition/ 2018.
2. V Kadambi, Manohar Prasad, An Introduction to Energy Conversion, Volume III, Turbo machinery

Reference books:

1. **S M Yahya**, Turbines, Fans and Compressors, Tata McGraw Hill, 2nd Edition
2. **D.G. Shepherd**, Principles of Turbomachines MacMillan, 1964.

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E-Books / Web References

1. Principles of Turbomachinery https://engineeringvideolectures.com/course/805
2. Fundamentals of Turbomachinery https://books.google.co.in/books?id=3NXzbV_YW_oC&printsec=copyright&redir_esc=y#v=onepage&q&f=false

MOOCs

1. https://onlinecourses.nptel.ac.in/noc21_me75/preview
2. https://nptel.ac.in/courses/112106200

Scheme of Examination: (Integrated courses)

Semester End Examination (SEE): SEE Question paper is to be set for 100 marks and the marks scored will be proportionately reduced to 50. There will be two full questions (with a maximum of four sub questions) from each module carrying 20 marks each. Students are required to answer any **five full questions** choosing at least **one full question from each module.**

Note: The laboratory assessment would be restricted to only the CIE evaluation.

Continuous Internal Evaluation (CIE): Three Tests are to be conducted for 40 marks each. The average of the three tests are taken for computation of CIE on a scale of 30, the CIE would also include laboratory evaluation for 20 marks. The laboratory marks of 20 would comprise of 10 marks for regular laboratory assessment to include lab record and observation. 10 marks would be exclusive for laboratory internal assessment test to be conducted at the end of the semester.

Typical Evaluation pattern for integrated courses is shown in the Table below

Table: Distribution of weightage for CIE & SEE of Integrated courses

	Component	Marks	Total Marks
CIE	CIE Test-1	**30**	**50**
	CIE Test-2	**30**	
	CIE Test-3	**30**	
	Laboratory	**20**	
SEE	Semester End Examination	**100**	**50**
		Grand Total	**100**

CO/PO Mapping															
CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO52.1	3	3	2	2	3		2		1	1				2	
CO52.2	3	3	2	2	3		2		1	1				2	
CO52.3	3	3	2	2	2		2		1	1				2	
CO52.4	3	3	2	2	2		2		1	1				2	
CO52.5	3	2	2	2	2		2		1	1				2	
Average	**3**	**3**	**2**	**3**	**3**		**2**		**1**	**1**				**2**	

Low - 1: Medium - 2: High - 3

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SEMESTER – V

Course: DESIGN OF MACHINE ELEMENTS

Course Code	**21MED53**	**CIE Marks**	**50**
Hours/Week (L: T: P)	**2 : 2 : 0**	**SEE Marks**	**50**
No. of Credits	**3**	**Examination Hours**	**03**

Prerequisites: Engineering Mechanics, Strength of Materials

Course Objectives: The students will be taught:

CO1	The steps in mechanical design procedure, materials, codes and use of standards and design for static strength, stress concentration
CO2	The analyse and design machine components for impact and fatigue strength.
CO3	Concepts and design of shafts, couplings and keys
CO4	to analyse and design riveted joints and welded joints
CO5	The design of pin joints and power screws.

Content	No. of Hours/ RBT levels
Module 1 Fundamentals of Mechanical Engineering Design, Phases of design process, Engineering Materials and their Mechanical properties, Standards and Codes, Factor of safety, Material selection. **Static Stresses:** Static loads Normal, Bending, Shear and Combined stresses. Theories of failure (No numerical).	**08 Hours / L1, L2, L3**
Module 2 **Stress concentration:** Determination of stress concentration factor, problems. **Impact Loads:** Impact stress due to Axial, Bending and Torsional loads.	**08 Hours / L1, L2, L3**
Module 3 **Design of Shafts:** Torsion of shafts, design for strength and rigidity with steady loading, ASME codes for power transmission shafting, shafts under combined loads. Simple problems. **Design of keys:** Simple Numerical on rectangular and square keys. **Design of Couplings:** Introduction, types of couplings, design of Rigid Flange coupling (protected and unprotected) & Bush and pin type flexible coupling.	**08 Hours / L1, L2, L3**
Module 4 **Riveted Joints:** Failures of riveted joints, Joint Efficiency, Boiler Joints, Riveted Brackets, eccentrically loaded joints. **Types of Welded joints:** Strength of butt and fillet welds, welded brackets with transverse and parallel fillet welds, eccentrically loaded welded joints.	**08 Hours / L1, L2, L3**

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Module 5	
Design of Cotter and Knuckle joints. **Power Screws:** Types of power screws, efficiency and self-locking, Design of power screws.	**08 Hours / L1, L2, L3**

COURSE OUTCOMES: Upon completion of this course, student will be able to:

CO53.1	Apply codes and standards, design processes, and failure theories to design and optimize machine members under static loads.
CO53.2	Analyze and mitigate stress concentration effects in machine members to enhance their resilience against impact loads.
CO53.3	Synthesize solutions for shafts, keys, and couplings by solving complex loading problems and optimizing their performance.
CO53.4	Evaluate the performance and reliability of structures utilizing various types of riveted and welded joints.
CO53.5	Optimize the design of knuckle and cotter joints, and determine the appropriate size of threaded fasteners for effective motion transmission between machine elements.

TEXT BOOKS:

1. **Mechanical Engineering Design,** Joseph E Shigley and Charles R.Mischke. McGraw Hill International edition, 6th Edition 2009.
2. **Design of Machine Elements,** V.B. Bhandari, Tata McGraw Hill Publishing Company Ltd., New Delhi, 2nd Edition 2007.

DESIGN DATA HAND BOOK:

1. **Design Data Hand Book, Volume 1,** K. Lingaiah, McGraw Hill, 2nd Edition.

REFERENCE BOOKS:

1. **Machine Design,** Robert L. Norton, Pearson Education Asia, 2001.
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. **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. **Fundamentals of Machine Component Design,** Robert C. Juvinall and Kurt M Marshek, Wiley India Pvt. Ltd., New Delhi, 3rd Edition, 2007.

WEB/ONLINE REFERENCES

www.nptel.ac.in

MOOCs

1. NPTEL Course: "Design of Machine Elements" http:// https://nptel.ac.in/courses/112/107/112107146/#
2. NPTEL Course: "Strength of Materials" (https://onlinecourses.nptel.ac.in/)
3. MOOC Course: "Machine Design", (https://www.coursera.org/courses?query=mechanics%20of%20materials)
4. Free Video Lectures: "Design of Machine Elements", (https://freevideolectures.com/course/96/)

Scheme of Examination: (Theory courses)

Semester End Examination (SEE):

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SEE Question paper is to be set for 100 marks and the marks scored will be proportionately reduced to 50. There will be two full questions (with a maximum of four sub questions) from each module carrying 20 marks each. Students are required to answer any **five full questions** choosing at least **one full question from each module.**

Continuous Internal Evaluation (CIE):

Three Tests are to be conducted for 50 marks each. The average of the three tests are taken for computation of CIE on a scale of 40. The assignment would be for a total of 10 marks,
CIE is executed by way of two quizzes / Other Assessment Tools (OATs), and three tests.

Some possible methods of assessment for assignments:

Assignments / Oral presentations / Group activity/Projects

Typical Evaluation pattern for regular courses is shown in Table 1.

Table 1: Distribution of weightage for CIE & SEE of Regular courses

	Component	Marks	Total Marks
CIE	CIE Test-1	**40**	**50**
	CIE Test-2	**40**	
	CIE Test-3	**40**	
	Assignment	**10**	
SEE	Semester End Examination	**100**	**50**
		Grand Total	**100**

CO/PO Mapping															
CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO53.1	3	2	2	1		1	1			1		2	2		
CO53.2	3	2	2	1		1	1			1		2	2		
CO53.3	3	2	2	1		1	1			1		2	2		
CO53.4	3	2	2	1		1	1			1		2	2		
CO53.5	3	2	2	1		1	1			1		2	2		
Average	**3**	**2**	**2**	**1**		**1**	**1**			**1**		**2**	**2**		

Low - 1: Medium - 2: High - 3

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SEMESTER – V

Course: Design for Manufacturing & Assembly

Course Code	21MED541	CIE Marks	50
Hours/Week (L: T: P)	3 : 0 : 0	SEE Marks	50
No. of Credits	3	Examination Hours	03

Prerequisites: Manufacturing Process I & II

Course Objectives: The students will be taught

CLO1	The basic design rules for manufacturing and material selection.
CLO2	The concept of production process for ease of manufacturing.
CLO3	The various factors to be considered for selection of metals and alloys and relationship to manufacturing processes
CLO4	The concepts of design for manufacturing and assembly for product manufacturing.
CLO5	The Comparison of various manufacturing processes and assembly techniques required for product development.

Content	No. of Hours/ RBT levels
Module 1 **Introduction:** Design Philosophy, steps in design process, General design rules for manufacturabilty; Basic principles of designing for economical production-creativity in design Materials: Selection of materials for design, Developments in materials technology, Criteria for materials selection, Material selection inter relationship with process selection	**8 Hours / L1, L2, L3**
Module 2 **Machining process**: Over view of various machining processes. General design rules for machining, Dimensional tolerance and surface roughness, Design for machining ease, Redesign of components for Machining ease with suitable examples, General design recommendations for machined parts.	**8 Hours / L1, L2, L3**
Module 3 **Metal casting**: Appraisal of various casting processes; selection of casting process, general design considerations for casting, casting tolerances, use of solidification simulation in casting design, product design rules for sand casting Metal joining: Appraisal of various welding processes, factors in design of weldments, general design guidelines, pre and post treatment of welds, effects of thermal stresses in welded joints, design of brazed joints	**8 Hours / L1, L2, L3**
Module 4 **Forging:** Design factors for forging, closed die forging, design parting lines of dies, drop forging die design, General design recommendations. EXTRUSION: Sheet metal work and plastics, Design guide lines for extruded sections, Design principles for punching, blanking, bending, deep drawing, Keeler -Goodman formability diagram,(forming limit diagram) Component design for blanking,	**8 Hours / L1, L2, L3**

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Module 5	
Design for assembly: General design guidelines for manual assembly, Development of systematic DFA methodology, Assembly efficiency, Classification system for manual handling, Classification system for manual insertion and fastening, Effect of part symmetry on handling time.	**8 Hours / L1, L2, L3**

COURSE OUTCOMES: Upon completion of this course, student will be able to:

CO541.1	Evaluate design rules for manufacturability to optimize production efficiency and product quality.
CO541.2	Assess general design recommendations to enhance the manufacturability and performance of machined parts.
CO541.3	Implement advanced design considerations and tolerance strategies to improve the quality and precision of cast components.
CO541.4	Develop innovative design solutions for extruded sections, adhering to advanced guidelines for manufacturability and functionality
CO541.5	Analyze the classification system for manual insertion and fastening, applying advanced design guidelines to improve assembly efficiency and reliability

Textbooks:

1. Product design for manufacture and assembly, Geoffry Booth royd, Peter Dewhurst and W. A. Knight, CRC Press, T1 .

Reference books:

1. K. Chitale and R.C. Gupt ‘‘Product design and Manufacturing” –prentice-Hall of India, New Delhi, 2003,
2. Kevin Otto and Kristin Wood, ”Production Design”, Person Education,
3. Surender Kumar, Goutham Sutradhar, ‘‘Design and Manufacturing”, oxford & IBH Publishing co, Pvt Ltd, 1998,

E-Books / Web References

1. https://link.springer.com/article/10.1007/s00170-022-08837-6#:~:text=Introduction-,The%20design%20for%20manufacturing%20and%20assembly%20(DFMA)%20is%20a%20family,of%20the%20product%20under%20development.
2. https://www.machinedesign.com/automation-iiot/article/21213546/a-history-of-design-for-manufacturing-and-assembly

MOOCs

1. NPTEL Course: “Design for Manufacture and Assemblyhttps://nptel.ac.in/courses/107103012

Scheme of Examination:

Semester End Examination (SEE):

SEE Question paper is to be set for 100 marks and the marks scored will be proportionately reduced to 50. There will be two full questions (with a maximum of four sub questions) from each module carrying 20 marks each. Students are required to answer any **five full questions** choosing at least **one full question from each module.**

Continuous Internal Evaluation (CIE):

Three Tests are to be conducted for 40 marks each. The average of the three tests are taken for computation of CIE. The assignment component would be for 10 marks. CIE is executed by way of quizzes / Alternate Assessment Tools (AATs), and three tests.

Some possible methods of assessment for assignments: Assignments/ Oral presentations / Group

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activity/Projects.

Typical Evaluation pattern for regular courses is shown in Table 2.

Table 2: Distribution of weightage for CIE & SEE of Regular courses

	Component	Marks	Total Marks
CIE	CIE Test-1	**40**	**50**
	CIE Test-2	**40**	
	CIE Test-3	**40**	
	Assignment/Quiz /AAT	**10**	
SEE	Semester End Examination	**100**	**50**
Grand Total			**100**

CO/PO Mapping															
CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO541.1	3	2	1	1		1		1		1		1			2
CO541.2	3	2	1	1		1		1		1		1			2
CO541.3	3	2	1	1		1		1		1		1			2
CO541.4	3	2	1	1		1		1		1		1			2
CO541.5	3	2	1	1		1		1		1		1			2
Average	**3**	**2**	**1**	**1**		**1**		**1**		**1**		**1**			**2**

Low - 1: Medium - 2: High – 3

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SEMESTER – V

Course: Energy, Environment and Sustainable Development

Course Code	21MED542	CIE Marks	50
Hours/Week (L: T: P)	3 : 0 : 0	SEE Marks	50
No. of Credits	3	Examination Hours	03

Prerequisites: -NIL-

Course Objectives: The students will be taught:

CLO1	The evaluation of economic frameworks for managing natural resources in development process
CLO2	The Energy Consumption Rates of conventional energy sources.
CLO3	The air and water quality standards.
CLO4	The need for solid waste management.
CLO5	The need and key concepts of sustainability.

Content	No. of Hours/ RBT levels
Module 1 **Introduction to Energy, Environment and Sustainability, Fundamental Dimensions and Systems of Units** Basic human needs, Energy, Environment, Sustainability, Simple Numerical Problems Fundamental Dimensions and Systems of Units, Dimensional Homogeneity and Unit Conversion, Components and Systems, Simple Numerical Problems **Renewable Energy for Sustainable Development- Challenges and Opportunities in India** Introduction, Renewable Energy in India, Policies and Regulations on Renewable Energy, Renewable Energy- SWOT Analysis, Renewable Energy Options for India	**08 Hours / L3**
Module 2 **Energy Consumption Rates and Non-Renewable Energy Sources** World Energy Consumption Rates, Fossil Fuels, Nuclear Energy **Energy and Agriculture in India, Population Growth and Environmental Degradation** Introduction, Energy to Agriculture, Energy from Agriculture, Trends in Population Growth, Effects of Population Growth on Environmental Sources, Population and Resource Depletion Problem, Caring Environment for Sustainable Development.	**08 Hours / L3**
Module 3 **Air and Air Quality Standards** Atmosphere, Weather and Climate, Green House Gases, Measurement of pollutants, Air quality and Health Issues, HVAC Systems, Methods to manage Contaminants, Global air Quality Issues **Water Resources, Consumption Rate, Quality Standards** and Basic Concepts of Water, Water Cycle, Properties of Water, Global Water Distribution, Global Water Quality Issues, Water for Life, Sources of Drinking Water and in India	**08 Hours / L3**

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Module 4 **Sources of Drinking Water in India, Overview of Water Crisis** Water for Life, Sources of Drinking Water and in India, Water Crisis, and Priorities of action **Municipal and Industrial Waste Solid Waste management** Introduction, Conceptualization, Groups of Waste, Objectives of Study, Solid Waste: Indian Scenario, Solid Waste- Different Views, Case study on Solid waste management	**08 Hours / L3**
Module 5 **Sustainability, Policy Interventions for Sustainable Environmental Management in India,** The Earth Charter, Key Sustainability Concepts, Assessments and Tools, Economics, Environment and Development- Theory and Practice, Sustainable Development and Environmental Management- International Initiatives, Legal Framework for Environmental Management Legislation, Policies for Sustainable Environmental Management- Ecological Economics Approach	**08 Hours / L3**

COURSE OUTCOMES: Upon completion of this course, student will be able to:

CO542.1	Evaluate the interconnections between energy, environment, and sustainable development within the Indian context to propose informed strategies for improvement.
CO542.2	Formulate innovative solutions to energy market issues and environmental challenges using advanced economic analysis and tools
CO542.3	Evaluate comprehensive insights into energy management systems, policies, and Acts to drive policy development and system improvements
CO542.4	Investigate and provide advanced solutions for water resource management and industrial solid waste management in India
CO542.5	Design for progressive sustainable energy management policies and legal frameworks to enhance sustainability and regulatory compliance in India

Textbooks:

1. "Exergy: Energy, Environment, and Sustainable Development", İbrahim Dinçer, Marc A. Rosen, Elsevier, Second Edition, 2007.
2. Energy, the Environment, and Sustainability By Efstathios E. Michaelides
3. Amlan Chakrabarti, Energy Engineering and Management, PHI, Eastern Economy Edition.

Reference books:

1. Energy Economics and the Environment: Conservation, Preservation and sustainability, Edition First Edition, Edited by: Mohammad Younus Bhat, Hiranmoy Roy, &M. S. Bhatt

E-Books / Web References

1. https://www.kobo.com/us/en/ebook/energy-the-environment-and-sustainability
2. https://www.taylorfrancis.com/books/mono/10.1201/b22169/energy-environment-sustainability-efstathios-michaelides

MOOCs

1. https://www.coursera.org/learn/exploring-renewable-energy

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2. https://www.mooc-list.com/course/renewable-power-and-electricity-systems-coursera
3. https://www.edx.org/professional-certificate/usmx-environmental-management-for-sustainability

Scheme of Examination:

Semester End Examination (SEE):

SEE Question paper is to be set for 100 marks and the marks scored will be proportionately reduced to 50. There will be two full questions (with a maximum of four sub questions) from each module carrying 20 marks each. Students are required to answer any **five full questions** choosing at least **one full question from each module.**

Continuous Internal Evaluation (CIE):

Three Tests are to be conducted for 40 marks each. The average of the three tests are taken for computation of CIE. The assignment component would be for 10 marks. CIE is executed by way of quizzes / Alternate Assessment Tools (AATs), and three tests.

Some possible methods of assessment for assignments: Assignments / Oral presentations / Group activity/Projects.

Typical Evaluation pattern for regular courses is shown in Table 2.

Table 2: Distribution of weightage for CIE & SEE of Regular courses

	Component	Marks	Total Marks
CIE	CIE Test-1	**40**	**50**
	CIE Test-2	**40**	
	CIE Test-3	**40**	
	Quiz /AAT	**10**	
SEE	Semester End Examination	**100**	**50**
Grand Total			**100**

CO/PO Mapping															
CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO542.1	3	2	2		3	1	1			1		1			1
CO542.2	3	2	2		3	1	1			1		1			1
CO542.3	3	2	2		3	1	1			1		1			1
CO542.4	3	2	2		3	1	1			1		1			1
CO542.5	3	2	2		3	1	1			1		1			1
	3	2	2		3	1	1			1		1			1

Low - 1: Medium - 2: High – 3

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SEMESTER – V

Course: Additive Manufacturing

Course Code	21MED543	CIE Marks	50
Hours/Week (L: T: P)	3 : 0 : 0	SEE Marks	50
No. of Credits	3	Examination Hours	03

Prerequisites: Elements of Mechanical Engineering

Course Objectives: This course will enable the students to:

CLO1	Understand the classification and steps involved in Additive Manufacturing.
CLO2	Describe the various techniques and applications of additive manufacturing.
CLO3	Identify various forms of raw materials used in additive manufacturing process.
CLO4	Describe the additive manufacturing equipment and process design.
CLO5	Discuss post processing techniques involved in additive manufacturing.

Content	No. of Hours/ RBT levels
Module 1 Introduction, Process, Classification, Advantages, Additive V/s Conventional Manufacturing processes, Applications. CAD for Additive Manufacturing: CAD Data formats, Data translation, Data loss, STL format.	**8 Hours / L1, L2, L3**
Module 2 Additive Manufacturing Techniques: Stereo-Lithography, LOM, FDM, SLS, SLM, Binder Jet technology. Process, Process parameter, Process Selection for various applications. Additive Manufacturing Application Domains: Aerospace, Electronics, Health Care, Defence, Automotive, Construction, Food Processing, Machine Tools.	**8 Hours / L1, L2, L3**
Module 3 Materials: Polymers, Metals, Non-Metals, Ceramics, Various forms of raw material- Liquid, Solid, Wire, Powder; Powder Preparation and their desired properties, Polymers and their properties, Support Materials.	**8 Hours / L1, L2, L3**
Module 4 Additive Manufacturing Equipment: Process Equipment- Design and process parameters, Governing Bonding Mechanism, Common faults and troubleshooting, Process Design.	**8 Hours / L1, L2, L3**
Module 5 Post Processing: Requirement and Techniques, Product Quality: Inspection and testing, Defects and their causes.	**8 Hours / L1, L2, L3**

LIST OF PRACTICALS

1. 3D Modelling of a single component.
2. Assembly of CAD modelled Components
3. Exercise on CAD Data Exchange.

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4. Generation of .stl files.
5. Identification of a product for Additive Manufacturing and its AM process plan.
6. Printing of identified product on an available AM machine.
7. Post processing of additively manufactured product.
8. Inspection and defect analysis of the additively manufactured product.
9. Comparison of Additively manufactured product with conventional manufactured counterpart

COURSE OUTCOMES: Upon completion of this course, student will be able to:

CO543.1	Develop CAD models for 3D printing Import and Export CAD data and generate .stl file.
CO543.2	Understand the generic process of additive Manufacturing and working principles of AM process
CO543.3	Select a specific material for the given application
CO543.4	Locate appropriate 3D printing hardware, diagnose typical issues, and perform troubleshooting
CO543.5	Perform post processing, and inspect the 3D printed parts to identify the defects, if any.

Textbooks:

1. Ian Gibson, David W. Rosen and Brent Stucker, Additive manufacturing technologies: rapid prototyping to direct digital manufacturing, Springer.
2. J.D. Majumdar and I. Manna, Laser-assisted fabrication of materials, Springer Series in Material Science, 2013.of Materials, 3rd Edition, CBS Publishers.

Reference books:

1. Andreas Gebhardt, Understanding additive manufacturing: rapid prototyping, rapid tooling, rapid manufacturing, Hanser Publishers.
2. C.K. Chua, K.F. Leong and C.S. Lim, Rapid prototyping: Principles and applications, 3rd Edition, World Scientific.
3. Additive Manufacturing: Principles, Technologies and Applications, C.P Paul, A.N Junoop, McGraw Hill, 2021.

E-Books / Web References

- https://www.nist.gov/additive-manufacturing
- https://www.metal-am.com/
- http://additivemanufacturing.com/basics/
- https://www.3dprintingindustry.com/

MOOCs

- NPTEL Course: ''Fundamentals of Additive Manufacturing Technologies'' https://nptel.ac.in/courses/112103306
- NPTEL Course: "Rapid Manufacturing" https://onlinecourses.nptel.ac.in/noc20_me50/preview
- MOOC Course: "Principle and development of additive manufacturing technologies", (https://onlinecourses.nptel.ac.in/noc19_me47/preview)

Scheme of Examination:

Semester End Examination (SEE):

SEE Question paper is to be set for 100 marks and the marks scored will be proportionately reduced to 50. There will be two full questions (with a maximum of four sub questions) from each module carrying 20 marks each. Students are required to answer any **five full questions** choosing at least **one full question from each module.**

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Continuous Internal Evaluation (CIE):

Three Tests are to be conducted for 40 marks each. The average of the three tests are taken for computation of CIE. The assignment component would be for 10 marks. CIE is executed by way of quizzes / Alternate Assessment Tools (AATs), and three tests.

Some possible methods of assessment for assignments: Assignments / Oral presentations / Group activity/Projects.

Typical Evaluation pattern for regular courses is shown in Table 2.

Table 2: Distribution of weightage for CIE & SEE of Regular courses

	Component	Marks	Total Marks
CIE	CIE Test-1	**40**	**50**
	CIE Test-2	**40**	
	CIE Test-3	**40**	
	Assignment/Quiz /AAT	**10**	
SEE	Semester End Examination	**100**	**50**
Grand Total			**100**

CO/PO Mapping															
CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO543.1	3	2	-	-	3	-	-	-	-	-	-	1			3
CO543.2	3	2	-	-	-	-	-	-	-	-	-	1			3
CO543.3	3	1	-	-	-	-	-	-	-	-	-	1			3
CO543.4	3	2	-	-	-	-	-	-	-	-	-	1			3
CO543.5	3	1	-	-	-	-	-	-	-	-	-	1			3
Average	3	2	-	-	1	-	-	-	-	-	-	1			3

Low - 1: Medium - 2: High – 3

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SEMESTER – V

Course: PRODUCT LIFE CYCLE MANAGEMENT

Course Code	21MED544	CIE Marks	50
Hours/Week (L: T: P)	3 : 0 : 0	SEE Marks	50
No. of Credits	3	Examination Hours	03

Prerequisites: Management & Entrepreneurship

Course Objectives: This course will enable the students to:

CLO1	Familiarize with various strategies of PLM
CLO2	Understand the concept of product design and simulation.
CLO3	Develop New product development, product structure and supporting systems
CLO4	Interpret the technology forecasting and product innovation and development in business processes.
CLO5	Understand product building and Product Configuration.

Content	No. of Hours/ RBT levels
Module 1 **INTRODUCTION TO PLM AND PDM** Introduction to PLM, Need for PLM, opportunities and benefits of PLM, different views of PLM, components of PLM, phases of PLM, PLM feasibility study. PLM Strategies, strategy elements, its identification, selection and implementation. Product Data Management, implementation of PDM systems.	**08 Hours / L3**
Module 2 **PRODUCT DESIGN** Engineering design, organization and decomposition in product design, product design process, methodical evolution in product design, concurrent engineering, design for 'X' and design central development model. Strategies for recovery at end of life, recycling, human factors in product design. Modelling and simulation in product	**08 Hours / L3**
Module 3 **PRODUCT DEVELOPMENT** New Product Development, Structuring new product development, building decision support system, Estimating market opportunities for new product, new product financial control, implementing new product development, market entry decision, launching and tracking new product program. Concept of redesign of product.	**08 Hours / L3**
Module 4 **TECHNOLOGY FORECASTING** Technological change, methods of technology forecasting, relevance trees, morphological methods, flow diagram and combining forecast of technologies Integration of technological product innovation and product development in business processes within enterprises, methods and tools in the innovation process according to the situation, methods and tools in the innovation process according to the situation.	**08 Hours / L3**

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Module 5 **PRODUCT BUILDING AND STRUCTURES** Virtual product development tools for components, machines, and manufacturing plants: 3D CAD systems, digital mock-up, model building, model analysis, production (process) planning, and product data technology, Product structures: Variant management, product configuration, material master data, product description data, Data models, Life cycles of individual items, status of items.	**08 Hours / L3**

COURSE OUTCOMES: Upon completion of this course, student will be able to:

CO1	Evaluate the implementation of Product Lifecycle Management (PLM) to enhance product development and lifecycle processes.
CO2	Optimize product design methodologies, including organization, decomposition, design for 'X', and the central development model, to improve product innovation and efficiency.
CO3	Develop advanced strategies for new product development, including market opportunity estimation, product launch, and tracking, to maximize market success and profitability
CO4	Implement cutting-edge technology forecasting and product innovation strategies to drive competitive advantage and business growth
CO5	Design advanced virtual product development tools to enhance product building and configuration, ensuring high-quality and efficient production processes

Textbooks:

1. Stark, John. Product Lifecycle Management: Paradigm for 21st Century Product Realization, Springer-Verlag, 2004. ISBN 1852338105
2. Fabio Giudice, Guido La Rosa, Product Design for the environment-A life cycle approach, Taylor & Francis 2006

Reference books:

1. Saaksvuori Antti / ImmonenAnselmie, product Life Cycle Management Springer,Dreamtech,3-540-25731-
2. Product Lifecycle Management, Michael Grieves, Tata McGraw Hill

E-Books / Web References

1. https://onlinecourses.swayam2.ac.in/imb19_mg01/preview
2. https://www.mygreatlearning.com/academy/learn-for-free/courses/product-lifecycle-management

MOOCs

1. https://nptel.ac.in/courses/110104084
2. https://nptel.ac.in/courses/112107217

Scheme of Examination: (Theory courses)

Semester End Examination (SEE):

SEE Question paper is to be set for 100 marks and the marks scored will be proportionately reduced to 50. There will be two full questions (with a maximum of four sub questions) from each module carrying 20 marks each. Students are required to answer any **five full questions** choosing at least **one full question from each module.**

Continuous Internal Evaluation (CIE):

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Three Tests are to be conducted for 40 marks each. Average of three tests is taken. CIE is executed by way of one quiz / Alternate Assessment Tools (AATs), and average of three tests. One quiz is conducted and evaluated for 10 marks.

Some possible methods of assessment for assignments: Assignments/ Oral presentations / Group activity/Projects

Typical Evaluation pattern for regular courses is shown in Table 2.

Table 2: Distribution of weightage for CIE & SEE

	Component	Marks	Total Marks
CIE	CIE Test-1	**40**	**50**
	CIE Test-2	**40**	
	CIE Test-3	**40**	
	Quiz/AAT	**10**	
SEE	Semester End Examination	**50**	**50**
Grand Total			**100**

CO/PO Mapping															
CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO544.1	3	1	1	1		1	1					1			1
CO544.2	3	1	1	1		1	1					1			1
CO544.3	3	1	1	1		1	1					1			1
CO544.4	3	1	1	1		1	1					1			1
CO544.5	3	1	1	1		1	1					1			1
Average	**3**	**1**	**1**	**1**		**1**	**1**					**1**			**1**

Low - 1: Medium - 2: High – 3

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SEMESTER – V

Course: Research Methodology

Course Code	21MED55	CIE Marks	50
Hours/Week (L: T: P)	3 : 0 : 0	SEE Marks	50
No. of Credits	3	Examination Hours	03

Course Objectives: The students will be taught:

CLO1	The basic concept of research and its methodologies
CLO2	To analyse and process the data using various techniques
CLO3	The skills in qualitative and quantitative data analysis and presentation.
CLO4	The ability to choose methods appropriate to research objectives.

Content	No. of Hours/ RBT levels
Module 1 **Research Methodology: Introduction** Definition of research, role and objectives of research, types of research, Research Approaches, Significance, Research Process, Criteria of Good Research, Problems Encountered by Researchers in India Defining the Research Problem, Technique involved in defining the problem. Definition of Research Design, Important Concepts Relating to Research Design, Different Research Designs, Basic Principles of Experimental Designs.	**8 Hours / L1, L2, L3**
Module 2 **Sampling Design:** Definition, Steps in Sampling Design, Criteria of Selecting a Sampling Procedure, Characteristics of a Good Sample Design, Different Types of Sample Designs, How to Select a Random Sample, Random Sample from an Infinite Universe, Complex Random Sampling Designs, simple numericals. **Measurement and Data collection:** Measurement Scales, sources of error in measurement, Collection of primary and secondary data, Case study method.	**8 Hours / L1, L2, L3**
Module 3 **Processing and Analysis of Data** Processing of data, Problems in processing, Types of analysis, Measures of central tendency, dispersion, skewness, Regression Analysis, simple numericals. **Sampling Fundamentals** Fundamental definitions, important fundamental distributions, sampling theory, Sandler's A-test, concept of standard error, estimation, estimation population proportion, simple numericals.	**8 Hours / L1, L2, L3**

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Module 4 **Testing of Hypotheses I** Hypotheses definition, basic concepts, Procedure for Hypothesis Testing, Flow Diagram for Hypothesis Testing, Important Parametric Tests, Hypothesis Testing of Means, Hypothesis Testing for Comparing Two Related Samples, Hypothesis Testing of Proportions, Simple numericals. **Chi-square Test** Chi-square as a Test for Comparing Variance, Chi-square as a Non-parametric Test, Conditions for the Application of χ2 Test, Steps Involved in Applying Chi-square Test, Simple numericals.	**8 Hours / L1, L2, L3**
Module 5 **Analysis of Variance and Covariance** Definition of Analysis of Variance (ANOVA), the Basic Principle of ANOVA, ANOVA Technique, Setting up Analysis of Variance Table, Short-cut Method for One-way ANOVA, Coding Method, Two-way ANOVA, Analysis of Co-variance (ANOCOVA), ANOCOVA Technique and its assumptions, Simple numericals.	**8 Hours / L1, L2, L3**

COURSE OUTCOMES:

Upon completion of this course, student will be able to:

CO55.1	Demonstrate the ability to comprehend the aims and objectives of research methodology and choose the appropriate research design
CO55.2	Explicate the various data collection and sampling techniques in research
CO55.3	Develop skills in data processing, analysis and estimating the error quantitatively
CO55.4	Explain the various hypothesis testing techniques instrumental in research
CO55.5	Apply basic data analytics techniques: ANOVA

Textbooks:

1. Research Methodology, C R Kothari, Gaurav Garg, 4th Edition, 2019, New Age International Publishers, ISBN: 978007008390-5
2. Research Methodology a step by step guide for beginners, Ranjith Kumar, SAGE Publications Ltd., 3rd Edition, 2011

Reference books:

1. Research Methods: the concise knowledge base, 1st edition, William Michael Trochim, Atomic Dog Publishing, 2005.
2. Fundamental of Research Methodology and Statistics, Yogesh Kumar Singh, Publisher: New Age International Pvt Ltd,2006.

E-Books / Web References

1. https://onlinecourses.nptel.ac.in/noc23_ge36/preview
2. https://onlinecourses.swayam2.ac.in/cec20_hs17
3. https://onlinecourses.nptel.ac.in/noc20_ge01
4. https://in.coursera.org/learn/research-methods

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Scheme of Examination:

Semester End Examination (SEE):

SEE Question paper is to be set for 100 marks and the marks scored will be proportionately reduced to 50. There will be two full questions (with a maximum of four sub questions) from each module carrying 20 marks each. Students are required to answer any **five full questions** choosing at least **one full question from each module.**

Continuous Internal Evaluation (CIE):

Three Tests are to be conducted for 40 marks each. The average of the three tests are taken for computation of CIE. The assignment component would be for 10 marks. CIE is executed by way of quizzes / Alternate Assessment Tools (AATs), and three tests.

Some possible methods of assessment for assignments: Assignments / Oral presentations / Group activity/Projects.

Typical Evaluation pattern for regular courses is shown in Table 2.

Table 2: Distribution of weightage for CIE & SEE of Regular courses

	Component	Marks	Total Marks
CIE	CIE Test-1	**40**	**50**
	CIE Test-2	**40**	
	CIE Test-3	**40**	
	Assignment/Quiz /AAT	**10**	
SEE	Semester End Examination	**100**	**50**
Grand Total			**100**

CO/PO Mapping															
CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO55.1	2	2		2		1	1	1	2	2	2	1			
CO55.2	2	2		2	2	1	1	1	2	2	2	1			
CO55.3	2	2		2	2	1	1	1	2	2	2	1			
CO55.4	2	2		2	2	1	1	1	2	2	2	1			
CO55.5	**2**	**2**		**2**	**2**	**1**	**1**	**1**	**2**	**2**	**2**	**1**			

Low - 1: Medium - 2: High - 3

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SEMESTER – V

Course: Ability Enhancement Course - III: Automation Through Hydraulics & Pneumatics

Course Code	**21MED56**	**CIE Marks**	**50**
Hours/Week (L: T: P)	**0 : 0 : 2**	**SEE Marks**	**50**
No. of Credits	**1**	**Examination Hours**	**03**

Prerequisites: Fluid Mechanics, Physics.

Course Objectives: To enable students to apply the knowledge of hydraulics and pneumatics in broad domain of mechanical engineering by making them to learn:

CLO1	Principles of working of Hydraulics and Pneumatics
CLO2	Components used in Hydraulics and Pneumatics
CLO3	Symbols used for circuit preparation
CLO4	Construction of Hydraulic and Pneumatic Circuits
CLO5	Troubleshooting of hydraulic and pneumatic circuits

Content	No. of Hours/ RBT levels
Basics: Hydraulic and Pneumatic working principles, applications. Hydraulic and Pneumatic components – compressor, valves and actuators. Working principle of actuators and valves with symbols and basic circuit preparation. Fault detection and identification in hydraulic and pneumatic circuits **Lab Component:** a. Direct & Indirect control of single and double acting cylinder b. Raising and lowering of the ladle using double piloted 5/2 directional control valve c. Pin Feeding Device with Limit switches d. Pin Feeding Device with speed control using Flow control valve e. Speed Control of Double acting cylinder using Meter in circuit f. Speed Control of Double acting cylinder using Meter out circuit. **Open ended experiments:** Billiards balls distribution from a gravity magazine using Logic gates	**12 Hours / L3**

COURSE OUTCOMES: Upon completion of this course, student will be able to

CO56.1	Understand the working principle of hydraulic and pneumatic systems
CO56.2	Demonstrate the working of Pneumatic and Hydraulic control systems
CO56.3	Apply principles of hydraulic and pneumatic controls for preparation of circuits
CO56.4	Analyze real time circuits of automated systems
CO56.5	Demonstrate troubleshooting of faulty hydraulic and pneumatic control circuits

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Textbooks:

1. **Anthony Esposito** Fluid Power with Applications, Sixth edition, Pearson Education, Inc, 2000.
2. **Andrew Parr** 'Pneumatics and Hydraulics', Jaico Publishing Co

Reference books:

1. **S. R. Majumdar** Oil Hydraulic systems', Principles and Maintenance, Tata McGraw Hill Publishing Company Ltd. - 2001
2. **Pippenger,** Hicks Industrial Hydraulics, " McGraw Hill, New York

E-Books / Web References

1. https://www.just.edu.jo/~haalshraideh/Courses/IE431/Lecture_slides/Hydrolics%20and%20Pneumatics.pdf

Scheme of Examination:

Table 1: Distribution of weightage for CIE & SEE

	Component	Marks	Total Marks
CIE	Circuit Fault detection and remedial measures activities	**30**	**50**
	Internal assessment test	**10**	
	Viva Voce	**10**	
SEE	Semester End Examination	**100**	**50**
		Grand Total	**100**

CO/PO Mapping															
CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO56.1					3										3
CO56.2	2				3		2								3
CO56.3		3		2	2		2								2
CO56.4	3	3		3			2								
CO56.5	3	2													
Average	**3**	**3**		**3**	**2**		**2**								**3**

Low - 1: Medium - 2: High - 3

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SEMESTER – V/VI

Course: Environmental Science

Course Code	21CIV57/67	CIE Marks	50
Hours/Week (L: T: P)	1:0:0	SEE Marks	50
No. of Credits	1	Examination Hours	1 hour

Course Learning Objectives:

CLO1	The fundamentals of environmental science.
CLO2	The types of natural resources
CLO3	The various global environmental concerns.
CLO4	The types of wastes generated and their handling at a basic level
CLO5	The area of environmental law and policies with a few important acts in the field

Content	No. of Hours/ RBT Levels
Module 1 **Environment:** • Definition, scope & importance • Components of Environment Ecosystem: Structure and function of various types of ecosystems • Human Activities – Food, Shelter, and Economic & Social Security. • Population - Growth, variation among nations – population explosion and impact on environment **Biodiversity:** Types, Value; Hot spots; Threats and Conservation of biodiversity, Forest Wealth, and Deforestation.	**04 Hours / L2**
Module 2 **Natural Resources**: Forest, Water, Mineral, Food, Energy, Land Environmental Pollution - Definition – causes, effects and control measures of: (a) Air pollution (b) Water pollution (c) Soil pollution (d) Marine pollution (e) Noise pollution (f) Thermal pollution (g) Nuclear hazards.	**04 Hours / L2**
Module 3 **Global Environmental Concerns** (Concept, policies and case-studies): Ground water depletion/recharging, Climate Change; Acid Rain; Ozone Depletion; Radon and Fluoride problem in drinking water; Resettlement and rehabilitation of people, Environmental Toxicology.	**04 Hours / L2**
Module 4 **Sources:** Sources of Solid waste, Types of solid waste, Physical and Chemical composition of municipal solid waste. Solid Waste Management Rules in India Sources and management of E – Waste, Biomedical Waste, Hazardous waste, and construction waste at individual and community level. Socio-economic aspect of waste management Environmental Toxicology.	**04 Hours / L2**
Module 5 **Latest Developments in Environmental Pollution Mitigation Tools** (Concept and Applications): Environment Impact Assessment, Environmental Management Systems, ISO14001; Environmental Stewardship, NGOs.	**04 Hours / L2**

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COURSE OUTCOMES: Upon completion of this course, student will be able to:

21CIV57.1/67.1	Understand holistically the key concepts "Environment", and "Biodiversity".
21CIV57.2/67.2	Classify the types of natural resources available and the effects of anthropogenic interventions.
21CIV57.3/67.3	Express the gravity of various global environmental concerns.
21CIV57.4/67.4	Categorize the types of wastes generated and their handling at a basic level.
21CIV57.5/67.5	Understand the importance of environmental law and policies.

Textbooks:

1. Environmental studies, Benny Joseph, Tata Mcgraw-Hill 2nd edition 2012
2. Environmental studies, S M Prakash, pristine publishing house, Mangalore 3rd edition-2018
3. Gilbert M.Masters, Introduction to Environmental Engineering and Science, 2nd edition, Pearson Education, 2004

Reference books:

1. Benny Joseph, Environmental studies, Tata Mcgraw-Hill 2nd edition 2009
2. M.Ayi Reddy Textbook of Environmental Science and Technology, BS publications 2007
3. Dr. B.S Chauhan, Environmental Studies, University of science press 1st edition

Web References:

https://www.hzu.edu.in/bed/E%20V%20S.pdf

https://onlinecourses.nptel.ac.in/noc23_hs155/preview

https://onlinecourses.swayam2.ac.in/cec19_bt03/preview

Scheme of Examination: Semester End Examination (SEE): SEE Question paper is to be set for 50 marks with multiple choice questions of 1 mark each covering all aspects of the syllabus.

Continuous Internal Evaluation (CIE): Three Tests are to be conducted for 50 marks each. The average of the three tests are taken for computation of CIE. Question paper for each of the CIE is to be of the multiple-choice type with 50 question each. Typical Evaluation pattern for regular courses is shown in Table.

Table 1: Distribution of weightage for CIE & SEE for 1 credit course

	Component	Marks	Total Marks
CIE	CIE Test-1	**50**	**50**
	CIE Test-2	**50**	
	CIE Test-2	**50**	
SEE	Semester End Examination	**50**	**50**
		Grand Total	**100**

CO/PO Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
21CIV57.1/67.1	2	-	-	-	-	-	3	-	-	-	-	-	1	-	-
21CIV57.2/67.2	2	1	-	-	-	-	3	-	-	-	-	1	1	-	1
21CIV57.3/67.3	2	-	2	-	-	2	3	1	-	-	-	1	1	-	1
21CIV57.4/67.4	2	2	-	-	-	2	3	-	-	-	-	-	-	-	1
21CIV57.5/67.5	2	-	-	-	-	2	3	-	-	-	-	-	-	1	1
Average	**2**	**2**	**2**	**-**	**-**	**2**	**3**	**1**	**-**	**-**	**-**	**1**	**1**	**1**	**1**

Low-1: Medium-2: High-3

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SEMESTER – V/VI

Course: Universal Human Values

Course Code	21UHV57/67	CIE Marks	50
Hours/Week (L: T: P)	1:0:0	SEE Marks	50
No. of Credits	1	Examination Hours	1 hour

Course Learning Objectives:

CLO1	To create an awareness on Engineering Ethics and Human Values.
CLO2	To understand social responsibility of an engineer.
CLO3	To appreciate ethical dilemma while discharging duties in professional life.

Content	No. of Hours
Module 1 **Introduction to Value Education** • Value Education, Definition, Concept and Need for Value Education. • The Content and Process of Value Education. • Basic Guidelines for Value Education, • Self-exploration as a means of Value Education. • Happiness and Prosperity as parts of Value Education.	**05 Hours**
Module 2 **Harmony in the Human Being** • Human Being is more than just the Body. • Harmony of the Self ('I') with the Body. • Understanding Myself as Co-existence of the Self and the Body. • Understanding Needs of the Self and the needs of the Body. • Understanding the activities in the Self and the activities in the Body.	**05 Hours**
Module 3 **Harmony in the Family and Society and Harmony in the Nature** • Family as a basic unit of Human Interaction and Values in Relationships. • The Basics for Respect and today's Crisis: Affection, Guidance, Reverence, Glory, Gratitude and Love, • Comprehensive Human Goal: The Five Dimensions of Human Endeavour. • Harmony in Nature: The Four Orders in Nature. • The Holistic Perception of Harmony in Existence.	**05 Hours**
Module 4 **Social Ethics** • The Basics for Ethical Human Conduct, Defects in Ethical Human Conduct. • Holistic Alternative and Universal Order, • Universal Human Order and Ethical Conduct. • Human Rights violation and Social Disparities.	**05 Hours**
Module 5 **Professional Ethics** • Value based Life and Profession., Professional Ethics and Right Understanding. • Competence in Professional Ethics. • Issues in Professional Ethics – The Current Scenario. • Vision for Holistic Technologies • Production System and Management Models.	**05 Hours**

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COURSE OUTCOMES: Upon completion of this course, student will be able to:

21UHV57.1/67.1	Understand the significance of value inputs in a classroom and start applying them intheir life and profession
21UHV57.2/67.2	Distinguish between values and skills, happiness and accumulation of physical facilities,the Self and the Body, Intention and Competence of an individual, etc.
21UHV57.3/67.3	Understand the role of a human being in ensuring harmony in society and nature.
21UHV57.4/67.4	Distinguish between ethical and unethical practices and start working out the strategy toactualize a harmonious environment wherever they work.

Textbooks:

1.A.N Tripathy, New Age International Publishers, 2003.
2.Bajpai. B. L, New Royal Book Co, Lucknow, Reprinted,
2004 3.Bertrand Russell Human Society in Ethics & Politics

Reference books:

4. Jeevan Vidya: Ek Parichaya, A Nagaraj, Jeevan Vidya Prakashan, Amarkantak, 1999.
5. Human Values, A.N. Tripathi, New Age Intl. Publishers, New Delhi, 2004.
6. Corliss Lamont, Philosophy of Humanism.
7. Gaur. R.R. , Sangal. R, Bagari G.P, A Foundation Course in Value Education, Excel Books, 2009.
8. Gaur. R.R. , Sangal R , Bagaria G.P, Teachers Manual, Excel Books, 2009.
9. I.C. Sharma, Ethical Philosophy of India, Nagin & co, Julundhar
10. William Lilly- Introduction to Ethics -Allied Publisher

Scheme of Examination: Semester End Examination (SEE): SEE Question paper is to be set for 50 marks with multiple choice questions of 1 mark each covering all aspects of the syllabus.

Continuous Internal Evaluation (CIE): Three Tests are to be conducted for 50 marks each. The average of the three tests are taken for computation of CIE. Question paper for each of the CIE is to be of the multiple-choice type with 50 question each.

Typical Evaluation pattern for regular courses is shown in Table.

Table 1: Distribution of weightage for CIE & SEE for 1 credit course

	Component	Marks	Total Marks
CIE	CIE Test-1	**50**	**50**
	CIE Test-2	**50**	
	CIE Test-3	**50**	
SEE	Semester End Examination	**50**	**50**
		Grand Total	**100**

CO/PO Mapping																
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
21UHV57.1/67.1	-	-	-	-	-	-	-	2	-	-	-	1	-	-	-	-
21UHV57.2/67.2	-	-	-	-	-	-	-	2	-	-	-	1	-	-	-	-
21UHV57.3/67.3	-	-	-	-	-	-	-	2	-	-	-	1	-	-	-	-
21UHV57.4/67.4	-	-	-	-	-	-	-	2	-	-	-	1	-	-	-	-
Average	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**-**	**-**	**-**	**1**	**-**	**-**	**-**	**-**

Low-1: Medium-2: High-3

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SEMESTER – V

Course: Fuel and Engine Testing Laboratory

Subject Code	**21MEDL58**	**CIE Marks**	**50**
Hours/Week (L: T: P)	**0 : 0 : 2**	**SEE Marks**	**50**
Credits	**1**	**Examination Hours**	**03**

Course Objectives: The students will be taught:

CLO1	The method used to determine the flash point & fire point, viscosity of lubricating oil and caloric value of all types fuels and lubricating oils.
CLO2	The methodology used in Conduction of experiments on IC engines, understand its performance and draw the characteristic curves .
CLO3	The method used to draw valve timing diagrams for IC engines
CLO4	The Experimental determination the calorific value of all types of fuels.

Sl. No.	Experiments	No. of Hours/ RBT levels
	Part- A	
1	Lab layout, calibration of instruments and standards to be discussed	**01 Hours / L3**
2	Determination of Flash point and Fire point of lubricating oil using Abel Pensky and Marten's Pensky Apparatus.	**01 Hours / L3**
3	Determination of Calorific value of solid, liquid and gaseous fuels.	**01 Hours / L3**
4	Determination of Viscosity of a lubricating oil using Redwoods, Saybolt and Torsion Viscometers.	**01 Hours / L3**
5	Valve Timing/port opening diagram of an I.C. Engine.	**01 Hours / L3**
	Part - B	
7	Performance Tests on I.C. Engines, Calculations of IP, BP, Thermal efficiency, Volumetric efficiency, Mechanical efficiency, SFC, FP, A:F Ratio, heat balance sheet for a. Four stroke Diesel Engine b. Four stroke Petrol Engine c. Multi Cylinder Diesel/Petrol Engine, (Morse test) d. Two stroke Petrol Engine e. Variable Compression Ratio I.C. Engine.	**05 Hours / L3**
8	Measurements of Exhaust Emissions of Petrol engine.	**01 Hours / L3**
9	Measurements of Exhaust Emissions of Diesel engine.	**01 Hours / L3**
Demonstration:		
1	Visit to Automobile Industry/service stations.	**01 Hours / L2**

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Course Outcomes: Upon successful completion of this course, student will be able to:

CO58.1	Evaluate the viscosity, flash point, fire point of fuels.
CO58.2	Determine the quality of Engine fuels by analyzing its calorific value.
CO58.3	Determine the actual valve timing for I C Engine and draw the diagram.
CO58.4	Analyze the various performance parameters at different operating conditions of an IC Engine.
CO58.5	Estimate the constituents of combustion products for emission characteristics related to public safety.

Textbooks:

1. C. Engines by V.Ganeshan, Tata McGraw Hill
2. I. C. Engines by Domkundwar & Domkundwar, Dhanpatrai
3. I. C. Engines by R.K.Rajput, Laxmi Prakashan
4. I. C. Engines by R. Yadav, Central Pub., Allahabad

References:

1. I.C. Engines by Heywood.
2. IC. Engines by Mathur & Sharma, Dhanpatrai

Scheme of Examination:

Semester End Examination (SEE):

	Component	Marks	Total Marks
SEE	PART- A	**15**	**50**
	PART- B	**25**	
	VIVA-VOCE	**10**	
SEE Total			**50**

Continuous Internal Evaluation (CIE):

	Component	Marks	Total Marks
CIE	MANUAL / RECORD	**20**	**50**
	CIE Test	**20**	
	VIVA-VOCE	**10**	
CIE Total			**50**

CO/PO Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO58.1	3	1		2											
CO58.2	3	1		2											
CO58.3	3	1		2											
CO58.4	3	1	2	2			1		1						
CO58.5	3	1	2	2			3								
Average	**3**	**1**	**2**	**2**			**2**		**1**						

Low - 1: Medium - 2: High - 3

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VI SEMESTER

SYLLABUS

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SEMESTER – VI
Course: Industrial Robotics

Course Code	**21MED61**	**CIE Marks**	**50**
Hours/Week (L: T: P)	**3: 0 : 0**	**SEE Marks**	**50**
No. of Credits	**3**	**Examination Hours**	**03**

Course Objectives: This course will enable the students to:

CLO1	Understand the fundamental concepts and technical specifications of industrial robotics, including robot anatomy, configurations, and control systems.
CLO2	Understand and apply the principles of 2D transformations and robot kinematics, including matrix representation and homogeneous transformations.
CLO3	Understand and derive the dynamic equations of motion for robotic systems using Lagrangian and Newton-Euler formulations.
CLO4	Understand and implement various trajectory planning methods for robotic motion in both joint space and Cartesian space.
CLO5	Understand key concepts and techniques in robot programming, including different programming levels and offline programming systems.

Content	No. of Hours/ RBT levels
Module 1 **Industrial Robotics:** Definition of Robotics, robot anatomy, joints and end effectors, Robotic configuration, Work volume, Robot motions, Robot drive system, Precision of movement: Spatial resolution, Accuracy and Repeatability. Degrees of freedom, Asimov's laws of robotics, Robot specifications Introduction to PID control systems, notations and symbols, position and orientation of rigid body, properties of rotation matrices about X-, Y- and Z-axis (simple numerical)	**08 Hours / L1, L2, L3**
Module 2 **Transformations:** 2D transformations, translation, rotation (Rotation about x, y, z axis) and scaling. Introduction to Direct and inverse kinematics. (only definition) **Robot kinematics:** Introduction- Matrix representation- rigid motion & homogeneous transformation- D-H representations.	**08 Hours / L1, L2, L3**
Module 3 **Robot Dynamics:** Kinetic energy, potential energy, Spring-mass-damper system using Lagrangian formulation. Equations of motion using Lagrangian – Euler formulations, equations of motion of 1- and 2- DoF, Newton-Euler formulations.	**08 Hours / L1, L2, L3**
Module 4 **Trajectory planning:** Joint space schemes, cubic trajectory, third order polynomial trajectory planning, Linear segments with Parabolic Blends (LSPB) trajectory. Cartesian space schemes – cartesian straight line and circular motion planning.	**08 Hours / L1, L2, L3**
Module 5 **Robot programming:** Introduction, levels of robot programming, requirements of robot programming language, problems pertaining to robot programming languages, offline programming systems, central issues in OLP systems, automating subtasks in OLP systems, simple programs on robot applications.	**08 Hours / L1, L2, L3**

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COURSE OUTCOMES: Upon completion of this course, student will be able to

CO61.1	Apply the principles of robot anatomy, configurations, and PID control systems to optimize the precision and efficiency of robotic movements in industrial applications.
CO61.2	Analyze 2D transformations, direct and inverse kinematics, and D-H representations to effectively model and control robotic movements.
CO61.3	Formulate and solve the equations of motion for robotic systems, including 1- and 2-degree-of-freedom (DoF) systems, using Lagrangian and Newton-Euler methods.
CO61.4	Develop trajectory planning techniques, including cubic and third-order polynomial trajectories, Linear Segments with Parabolic Blends (LSPB), as well as Cartesian straight line and circular motion planning for robotic systems.
CO61.5	Develop robot programs, addressing issues related to robot programming languages, offline programming systems, and automating subtasks, while implementing simple programs for practical robot applications.

Textbooks:

1. Computer Integrated Manufacturing - Mikell P. Groover, Pearson, 3rd edition, 2009
2. Introduction to robotics mechanics and control - John J. Craig, Pearson, 3rd edition, 2009

Reference books:

1. Robotics for Engineers - Yoram Koren, McGraw Hill International, 1st edition, 1985.
2. Industrial Robotics - Weiss, Nagel, McGraw Hill International, 2nd edition, 2012.
3. Robotic Engineering - An Integrated approach, Klafter, Chmielewski and Negin, PHI, 1st edition, 2009.
4. Computer Based Industrial Control - Krishna Kant, EEE-PHI, 2nd edition, 2010.
5. An Introduction to Automated Process Planning Systems- Tiess Chiu Chang & Richard A. Wysk.

E-Books / Web References

1. **Fundamentals of Robot Technology**: An Introduction to Industrial Robots, Tele operators and Robot Vehicles: https://www.pdfdrive.com/fundamentals-of-robot-technology-an-introduction-to-industrial-robots-teleoperators-and-robot-vehicles-d157678284.html
2. **Robot Operating System for Absolute Beginners**: Robotics Programming Made Easy: https://www.pdfdrive.com/robot-operating-system-for-absolute-beginners-robotics-programming-made-easy-e176394485.html
3. **Introduction to Robotics:**
   - http://www.mech.sharif.ir/c/document_library/get_file?uuid=5a4bb247-1430-4e46-942c-d692dead831f&groupId=14040
   - https://www.researchgate.net/publication/273697873_Introduction_to_Robotics

MOOCs

1. NPTEL Course: "ROBOTICS" : https://nptel.ac.in/courses/112105249
2. NPTEL Course: "Introduction to Robotics": https://onlinecourses.nptel.ac.in/noc20_de11/preview

Scheme of Examination: (Theory courses)

Semester End Examination (SEE):

SEE Question paper is to be set for 100 marks and the marks scored will be proportionately reduced to 50. There will be two full questions (with a maximum of four sub questions) from each module

carrying 20 marks each. Students are required to answer any **five full questions** choosing at least **one full question from each module.**

Continuous Internal Evaluation (CIE):

Three Tests are to be conducted for 40 marks each. The average of the three tests are taken for computation of CIE on a scale of 40.

CIE is executed by way of two quizzes / Other Assessment Tools (OATs), and three tests.

Some possible AATs: Assignments / Oral presentations / Group activity/Projects

Typical Evaluation pattern for regular courses is shown in Table 2.

Table 2: Distribution of weightage for CIE & SEE of Regular courses

	Component	Marks	Total Marks
CIE	CIE Test-1	**40**	**50**
	CIE Test-2	**40**	
	CIE Test-3	**40**	
	QUIZ/OAT	**10**	
SEE	Semester End Examination	**100**	**50**
		Grand Total	**100**

CO/PO Mapping															
CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO61.1	3	2	2	1	-	1	-	-	-	-	-	2	2	-	-
CO61.2	3	2	2	1	-	1	-	-	-	-	-	2	2	-	-
CO61.3	3	2	2	1	-	1	-	-	-	-	-	2	2	-	-
CO61.4	3	2	2	1	-	1	-	-	-	-	-	2	2	-	-
CO61.5	3	2	2	1	-	1	-	-	-	-	-	2	2	-	-
Average	3	2	2	1	-	1	-	-	-	-	-	2	2	-	-

Low - 1: Medium - 2: High - 3

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SEMESTER – VI

Course: HEAT TRANSFER (Integrated)

Course Code	21MED62	CIE Marks (Theory + Lab)	30 + 20 = 50
Hours/Week (L: T: P)	3 : 0 : 2	SEE Marks	50
No. of Credits	4	Examination Hours	03

Prerequisites:

Course Objectives: The students will be taught:

CLO1	The types of heat transfer applied to engineering systems
CLO2	Various engineering correlations used in heat transfer analysis and their application in thermal design of engineering components and systems.
CLO3	The heat transfer process parameters used in solving engineering problems related to conduction, convection, and radiation
CLO4	The boundary layer concept in forced and free convection problems
CLO5	Boiling and condensation concepts to use in the design of heat exchangers

Content	No. of Hours/ RBT levels
Module 1 **Basic Concepts:** Modes of heat transfer: Basic laws governing conduction, convection and radiation heat transfer, Thermal conductivity; Convective heat transfer co-efficient, General 3 – dimensional heat conduction equation in Cartesian co-ordinates. (No derivations) **Steady state heat conduction:** Steady state heat conduction in plane wall and multilayer walls, Thermal contact resistance, discussion on 3-D conduction in cylindrical and spherical coordinate systems, (No derivations) **Demonstration and Hands on:** *Demonstration - I* **Laboratory:** *Laboratory Exercise – I, II*	**8 Hours / L1, L2, L3**
Module 2 **Heat transfer in extended surfaces (Fins)** – infinitely long fin, fin with insulated tip and fin with convective heat transfer at the tip, Fin Efficiency or Effectiveness. Numerical problems on Fin Heat Transfer, (No derivations) **Demonstration and Hands on:** *Demonstration - II* **Laboratory:** *Laboratory Exercise – III*	**8 Hours / L1, L2, L3**

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Module 3 **Forced Convection**: Dimensional analysis, Physical significance of Reynolds, Prandtl, Nusselt and Stan**ton** numbers. Use of empirical correlations for flow over a flat plate, over a cylinder and spheres. Numerical problems. (No derivations) **Free Convection**: Dimensional analysis for free convection - physical significance of Grashof number; use of experimental correlations for Free convection from or to Vertical, Horizontal plates and cylinders, and spheres. (No derivations) **Laboratory:** *Laboratory Exercise – IV, V*	**8 Hours / L1, L2, L3**
Module 4 **Condensation Heat Transfer**: Dropwise and film wise Condensation on a Vertical Flat Surface; Film Thickness and Heat Transfer Coefficient; Correlations for Condensation on Horizontal Tube and Horizontal Tube Banks; Numerical problems. (No derivations). **Heat Exchangers:** Classification of Heat Exchangers; Overall Heat Transfer coefficient, Fouling and Fouling factor; LMTD, Effectiveness-NTU methods of analysis of Heat Exchangers, Numerical problems. **Laboratory:** *Laboratory Exercise – VI and VII*	**8 Hours / L1, L2, L3**
Module 5 **Radiation Heat Transfer:** Thermal Radiation; definitions of various terms; Stefan-Boltzmann's law, Kirchhoff's law, Planck's law and Wein's Displacement law. Radiation heat exchange between two parallel infinite black surfaces, between two parallel infinite gray surfaces; effect of Radiation Shield; Numerical Problems. **Laboratory:** *Laboratory Exercise – VIII and IX*	**8 Hours / L1, L2, L3**

COURSE OUTCOMES: Upon completion of this course, student will be able to:

CO62.1	Analyze and compute conduction heat transfer across various geometries.
CO62.2	Quantify thermal energy transfer in both steady-state and transient scenarios by employing advanced charts and correlation tables.
CO62.3	Apply the boundary layer concept to critically examine and interpret heat flow through bodies with different cross-sections concerning forced and free convection.
CO62.4	Evaluate and optimize heat transfer rates for complex phase transformation problems, including condensation, evaporation, and heat exchangers.
CO62.5	Synthesize and critically review fundamental concepts and laws of radiation and assess radiation exchange between two finite bodies.

Laboratory:

Exercise Number	Experiment	No. of Hours/ RBT Levels
I & II	Determination of Thermal Conductivity of a Metal Rod, Determination of Overall Heat Transfer Coefficient of a Composite wall.	01 Hours/ L3
III	Determination of Effectiveness on a Metallic fin.	01 Hours/ L3
IV & V	Determination of Heat Transfer Coefficient in a free Convection on a vertical cylinder, Determination of Heat Transfer Coefficient in a forced Convection through a pipe	02 Hours/ L3
VI & VII	Determination of LMDT and Effectiveness in a Parallel Flow and	02 Hours/ L3

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	Counter Flow Heat Exchanger.	
VIII & IX	Determination of Emissivity of a Surface, Determination of Stefan Boltzmann Constant.	02 Hours/ L3
Demonstration – I	Determination of temperature distribution along fin subjected to heat loss through convection using Numerical approach (ANSYS/CFD package)	02 Hours/ L3

Textbooks:

1. **Yunus A. Cengel, Afshin J Ghajar –** Heat and Mass Transfer, Fundamentals and Applications, Sixth edition, Tata Mc Graw Hill.
2. **Er.R.K. Rajput,** A textbook of Heat and Mass Transfer, Revised Edition, 2019, S Chand and Company Ltd.

Reference books:

1. **Incropera, F. P. and De Witt,** Fundamentals of Heat and Mass Transfer, D. P., 5th Edition, John Wiley and Sons, New York, 2006.
2. **M. Necati Ozisik,** Heat Transfer, A Basic Approach, McGraw Hill, New York, 2005.
3. **Holman, J. P,** Heat Transfer, 9th Edition, Tata McGraw Hill, New York, 2008.

E-Books / Web References

1. https://www.pdfdrive.com/heat-transfer-d19467627.html

MOOCs

1. NPTEL Course: "Heat and Mass Transfer" (https://nptel.ac.in/courses/112101097)
2. MOOC Course: "Heat and Mass Transfer" (https://www.coursera.org)
3. Free Video Lectures: "Heat and Mass transfer", (https://freevideolectures.com/course/3533/convective-heat-transfer)

Scheme of Examination: (Integrated courses)

Semester End Examination (SEE):

SEE Question paper is to be set for 100 marks and the marks scored will be proportionately reduced to 50. There will be two full questions (with a maximum of four sub questions) from each module carrying 20 marks each. Students are required to answer any **five full questions** choosing at least **one full question from each module.**

Note: The laboratory assessment would be restricted to only the CIE evaluation.

Continuous Internal Evaluation (CIE):

Three Tests are to be conducted for 40 marks each. The average of the three tests are taken for computation of CIE on a scale of 30, the CIE would also include laboratory evaluation for 20 marks. The laboratory marks of 20 would comprise of 10 marks for regular laboratory assessment to include lab record and observation. 10 marks would be exclusive for laboratory internal assessment test to be conducted at the end of the semester.

Typical Evaluation pattern for integrated courses is shown in the Table below

Table: Distribution of weightage for CIE & SEE of Integrated courses

	Component	Marks	Total Marks
CIE	CIE Test-1	**30**	**50**
	CIE Test-2	**30**	
	CIE Test-3	**30**	
	Laboratory	**20**	
SEE	Semester End Examination	**100**	**50**
		Grand Total	**100**

CO/PO Mapping															
CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO62.1	3	2	1	1		1	1	1	1	1		1		1	
CO62.2	3	2	1	1		1	1	1	1	1		1		1	
CO62.3	3	2	1	1		1	1	1	1	1		1		1	
CO62.4	3	2	1	1		1	1	1	1	1		1		1	
CO62.5	3	2	1	1		1	1	1	1	1		1		1	
Average	**3**	**2**	**1**	**1**		**1**	**1**	**1**	**1**	**1**		**1**		**1**	

Low - 1: Medium - 2: High – 3

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SEMESTER – VI

Course: FINITE ELEMENT METHODS (Integrated)

Course Code	**21MED63**	**CIE Marks**	**30 + 20 = 50**
Hours/Week (L: T: P)	**3 : 0 : 2**	**SEE Marks**	**50**
No. of Credits	**4**	**Examination Hours**	**03**

Prerequisites: Strength of Materials

Course Objectives: This course will enable the students to:

CLO1	Learn basic concepts of the Finite Element Method (FEM) and elasticity theory for engineering problems.
CLO2	Use polynomial interpolation and element formulations to solve engineering problems in finite element analysis
CLO3	Use stiffness matrices for bars, trusses, and beams, solve problems with different loads, and analyze 1-D heat transfer.
CLO4	Apply Lagrange's interpolation methods and numerical integration techniques in finite element analysis.
CLO5	Use key numerical methods to solve engineering problems.

Content	No. of Hours/ RBT levels
Module 1 **Introduction to Finite Element Method**: Definition of FEM, General steps of the finite element method. Engineering applications of finite element method. Advantages of the Finite Element Method. Types of elements based on geometry (1D, 2D, 3D Elements), Size of elements, Location of nodes, Banded matrix and effect of node numbering on banded matrix. **Basics of theory of elasticity:** Stress and strain tensor, Plane stress and Plane strain, Equilibrium conditions (No derivation), strain displacement relation, Stress-Strain relations. **Laboratory**: Introduction to FEM Software (Ansys APDL and Workbench)	**10 Hrs./ L1, L2, L3**
Module 2 **Polynomial form of interpolation**: PASCAL's triangle, Convergence criteria, Simplex, complex, and multiplex elements, Global and natural coordinate system, Stiffness matrix, iso-, sub- and super parametric elements. **Analysis of Bars**: Stiffness matrix (direct stiffness method), Shape functions in Global and Natural coordinate systems, Numerical on stepped bars subjected to axial loads. **Laboratory**: Analysis of Bars	**10 L1, L2, L3**
Module 3 **Analysis of trusses**: Stiffness matrix, Numerical on truss structures (Maximum 3 members only)	**10 L1, L2, L3**

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Lagrange's form of interpolation: Higher order elements, Shape functions of quadratic bar element, CST elements, quad element. Numerical integration: Gauss quadrature one point, two-point and three-point formulae. **Laboratory**: Analysis of Trusses	
Module 4 **Analysis of beams:** Formulation of stiffness matrix and load vectors, Hermite shape functions (no derivation), Numerical on FE solution for beam structures with point load, UDL and UVL. **Dynamic Analysis:** Mass matrices, Consistent element mass matrices for bar and truss elements, Evaluation of Eigenvalue and Eigen vectors of bars and beam elements. **Laboratory**: Static and Dynamic analysis of Beams	**10** **L1, L2, L3**
Module 5 **Heat Transfer Analysis:** 1-D steady state heat transfer, Heat transfer through slabs with different boundary conditions, one dimensional heat transfer in thin fins, problems **Numerical Methods:** Potential energy method, Rayleigh Ritz and Galerkin's method (simple numerical) **Laboratory**: Analysis of Plane stress and Plain Strain elements (2D) Analysis of Heat transfer through Composite Walls	**10** **L1, L2, L3**

COURSE OUTCOMES: Upon completion of this course, student will be able to:

CO63.1	Evaluate different element types in FEM and their impacts and integrate advanced elasticity concepts to derive and solve practical engineering challenges.
CO63.2	Analyze simplex, complex, and multiplex elements, and iso-, sub-, and super-parametric elements.
CO63.3	Formulate and apply stiffness matrices for bars, trusses, and beams, solve numerical problems involving axial loads and various loading conditions, and analyze 1-D steady-state heat transfer in different scenarios.
CO63.4	Utilize Lagrange's interpolation for higher-order elements, including quadratic bar elements, CST elements, and quad elements, and apply Gauss quadrature methods for numerical integration with one, two, and three points.
CO63.5	Apply the Potential Energy Method, Rayleigh-Ritz Method, and Galerkin's Method to solve engineering problems through simple numerical examples.

Textbooks:

1. Finite Element Method in Engineering, S.S. Rao, 4th Edition, Elsevier, 2006.
2. Finite Element Methods, Daryl. L. Logon, Thomson Learning 3rd edition, 2001

Reference books:

1. J.N.Reddy, "Finite Element Method"- McGraw -Hill International Edition. Bathe K. J. Finite Elements Procedures, PHI. 2.
2. Cook R. D., et al. "Concept sand Application of Finite Elements Analysis"- 4th Edition, Wiley & Sons, 2003.

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E-Books / Web References

1. https://www.youtube.com/watch?v=C6X9Ry02mPU
2. https://www.youtube.com/watch?v=GHjopp47vvQ
3. https://www.youtube.com/watch?v=MC8pTORcKJM

MOOCs

1. https://www.youtube.com/watch?v=UOp6JEiJctA-(NPTEL)

Scheme of Examination: (Integrated courses)

Semester End Examination (SEE):

SEE Question paper is to be set for 100 marks and the marks scored will be proportionately reduced to 50. There will be two full questions (with a maximum of four sub questions) from each module carrying 20 marks each. Students are required to answer any **five full questions** choosing at least **one full question from each module.**

Note: The laboratory assessment would be restricted to only the CIE evaluation.

Continuous Internal Evaluation (CIE):

Three Tests are to be conducted for 40 marks each. The average of the three tests are taken for computation of CIE on a scale of 30, the CIE would also include laboratory evaluation for 20 marks. The laboratory marks of 20 would comprise of 10 marks for regular laboratory assessment to include lab record and observation. 10 marks would be exclusive for laboratory internal assessment test to be conducted at the end of the semester.

Typical Evaluation pattern for integrated courses is shown in the Table below

Table: Distribution of weightage for CIE & SEE of Integrated courses

	Component	Marks	Total Marks
CIE	CIE Test-1	**30**	**50**
	CIE Test-2	**30**	
	CIE Test-3	**30**	
	Laboratory	**20**	
SEE	Semester End Examination	**100**	**50**
		Grand Total	**100**

CO/PO Mapping															
CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO63.1	3	2	2	-	3	1	-	-	1	2	-	2	2	-	-
CO63.2	3	2	2	-	3	1	-	-	1	2	-	2	2	-	-
CO63.3	3	2	2	-	3	1	-	-	1	2	-	2	2	-	-
CO63.4	3	2	2	-	3	1	-	-	1	2	-	2	2	-	-
CO63.5	3	2	2	-	3	1	-	-	1	2	-	2	2	-	-
Average	3	2	2	-	3	1	-	-	1	2	-	2	2	-	-

Low - 1: Medium - 2: High - 3

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SEMESTER – VI
Course: Mechanical Vibrations

Course Code	**22MED641**	**CIE Marks**	**50**
Hours/Week (L: T: P)	**3: 0 : 0**	**SEE Marks**	**50**
No. of Credits	**3**	**Examination Hours**	**03**

Prerequisites: Engineering Mechanics

Course Objectives: This course will enable the students to:

CLO1	Understand the fundamentals of Vibration Theory.
CLO2	Mathematically model real-world mechanical vibration problems.
CLO3	Determine natural frequencies of undamped, damped and forced vibrating systems of one, degree freedom systems.
CLO4	Learn the process of vibration measurements and control.
CLO5	Understand the fundamental principles of maintenance and condition monitoring techniques.

Content	No. of Hours/ RBT levels
Module 1 **Undamped (Single Degree of Freedom) Free Vibrations** **Introduction to Vibrations, Types of vibrations,** Derivations for spring mass systems, Methods of Analysis, Natural frequencies of simple systems, Springs in series and parallel, Torsional and Transverse vibrations, Effect of mass of spring and Problems.	**8** **L1,L2,L3**
Module 2 **Damped free vibrations** Types of damping, Analysis with viscous damping - Derivations for over, critical and under damped systems, Logarithmic decrement and Problems.	**8** **L1,L2,L3**
Module 3 **Forced Vibrations** Introduction, Analysis of forced vibration with constant harmonic excitation - magnification factor, rotating and reciprocating unbalances, excitation of support (relative and absolute amplitudes), force and motion transmissibility.	**8** **L1,L2,L3**
Module 4 **Vibration Measuring Instruments and Whirling of shafts: Seismic Instruments** Vibrometers, Accelerometer, Frequency measuring instruments and Problems. Whirling of shafts with and without damping, discussion of speeds above and below critical speeds and Problems.	**8** **L1,L2,L3**

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Module 5	
Modal analysis and Condition Monitoring Signal analysis, dynamic testing of machines and structures, Experimental modal analysis, Machine condition monitoring and diagnosis.	**8** **L1, L2,L3**

COURSE OUTCOMES: Upon completion of this course, student will be able to:

CO641.1	Develop advanced mathematical models for analyzing and optimizing simple vibration systems.
CO641.2	Formulate the equation of motion, natural frequency, damping factor, and logarithmic decrement for complex damped free vibration (SDOF) systems.
CO641.3	Evaluate complex forced vibration issues using frequency response curves, phase angle plots, vibration isolation techniques, and transmissibility analysis.
CO641.4	Optimize the use of seismic and frequency measuring instruments, and critically analyze and solve problems related to the critical speed of shafts with and without damping.
CO641.5	Design and implement advanced vibration-based condition monitoring systems to enhance the reliability and performance of engineering applications.

Textbooks:

1. Mechanical Vibrations, S. S. Rao, Pearson Education Inc, 4th edition, 2003.
2. Mechanical Vibrations, V. P. Singh, Dhanpat Rai & Company, 3rdedition, 2006.

Reference books:

3. Theory of Vibration with Applications, W. T. Thomson, M. D. Dahleh and C. Padmanabhan, Pearson Education Inc, 5th edition, 2008.
4. Mechanical Vibrations: S. Graham Kelly, Schaum's outline Series,Tata McGraw Hill, Special Indian Edition, 2007.
5. Theory and Practice of Mechanical Vibrations: J. S. Rao &K.Gupta, New Age International Publications, New Delhi, 2001.
6. Mechanical Vibrations, G. K.Grover, Nem Chand and Bros, 6th edition, 1996

E-Books / Web References

2. https://www.youtube.com/watch?v=-WCBkuGTtz8&list=PLMgYkY7H7uuScB-VW9d81PW-kyWp0tY05 (complete videos on vibrations – all syllabus)
3. https://www.math.nyu.edu/faculty/childres/vibes.pdf
4. http://vdol.mae.ufl.edu/CourseNotes/EML4220/vibrations.pdf

MOOCs

1. **https://nptel.ac.in/courses/112107212**
2. **https://nptel.ac.in/courses/112107087**

Scheme of Examination:

Semester End Examination (SEE):

SEE Question paper is to be set for 100 marks and the marks scored will be proportionately reduced to 50. There will be two full questions (with a maximum of four sub questions) from each module carrying 20 marks each. Students are required to answer any five full questions choosing at least **one full question from each module**.

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Continuous Internal Evaluation (CIE):

Three Tests are to be conducted for 40 marks each. Average of three tests is taken. CIE is executed by way of one quiz / Alternate Assessment Tools (AATs), and average of three tests. One quiz is to be conducted and evaluated for 10 marks

Some possible AATs:

Assignments/ group activity / any other.

Typical Evaluation pattern for regular courses is shown in Table 2.

Table 2: Distribution of weightage for CIE & SEE of Regular courses

	Component	Marks	Total Marks
CIE	CIE Test-1	**40**	**50**
	CIE Test-2	**40**	
	CIE Test-2	**40**	
	Quiz /AAT	**10**	
SEE	Semester End Examination	**50**	**50**
Grand Total			**100**

CO/PO Mapping															
CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO641.1	2	2	1	1		1	1					1	3		
CO641.2	2	2	1	1		1	1					1	3		
CO641.3	2	2	1	1		1	1					1	3		
CO641.4	2	2	1	1		1	1					1	3		
CO641.5	2	2	1	1		1	1					1	3		
Average	**2**	**2**	**1**	**1**		**1**	**1**					**1**	**3**		

Low - 1: Medium - 2: High - 3

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SEMESTER – VI

Course: Automotive Engineering and Hybrid Vehicle technology

Course Code	21MED642	CIE Marks	50
Hours/Week (L: T: P)	3 : 0 : 0	SEE Marks	50
No. of Credits	03	Examination Hours	03

Prerequisites: Elements of Mechanical engineering

Course Objectives: the students are taught to:

CLO1	Relate the functions and importance of automotive parts and their performance
CLO2	Know the working of transmission and brake systems.
CLO3	Gain the knowledge of operation and working of steering and suspension systems.
CLO4	The concepts of various Injection system and its advancements.
CLO5	Understand the Hybrid Vehicle technology, Automobile emissions control techniques & the Norms

Content	No. of Hours/ RBT levels
Module 1 **ENGINE COMPONENTS AND IT'S PARTS**: Spark Ignition (SI) & Compression Ignition (CI) engines, cylinder – arrangements and their relative merits, Liners, Piston, connecting rod, crankshaft, valves, valve actuating mechanisms, valve and port timing diagrams, Types of combustion chambers for S.I. Engine and C.I. Engines. **COOLING AND LUBRICATION**: Cooling requirements, Types of cooling- Thermo siphon system, forced circulation water cooling system, water pump, Radiator, Significance of lubrication, Splash and Forced feed system.	**08 Hours / L1, L2, L3**
Module 2 **FUELS, FUEL SUPPLY SYSTEMS FOR SI AND CI ENGINES**: Conventional fuels, Alternative fuels, Normal and Abnormal combustion, Cetane and Octane numbers, Fuel mixture requirements for SI engines, Types of carburettors, Multi point and Single point fuel injection systems, fuel transfer pumps, Fuel filters, fuel injection pumps and injectors. Electronic Injection system, Common Rail Direct Injection System. **SUPERCHARGERS AND TURBOCHARGERS**: Naturally aspirated engines, Forced Induction, Types of superchargers, Turbocharger construction and operation, Intercooler, Turbocharger lag.	**08 Hours / L1, L2, L3**

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Module 3 **TRANSMISSION SYSTEMS**: Clutch-types and construction, gear boxes- manual and automatic, gear shift mechanisms, over drive, transfer box, fluid flywheel, torque converter, propeller shaft, slip joints, universal joints. Differential and rear axle, Hotchkiss Drive and Torque Tube Drive. **BRAKES**: Types of brakes, mechanical compressed air, vacuum, and hydraulic braking system construction and working of master and wheel cylinder, brake shoe arrangements, Disk brakes, drum brakes, Antilock –Braking systems,	**08 Hours / L1, L2, L3**
Module 4 **STEERING AND SUSPENSION SYSTEMS**: Steering geometry and types of steering gear box-Power Steering, Types of Front Axle, Suspension, Torsion bar suspension systems, leaf spring, coil spring, independent suspension for front wheel and rear wheel, Air suspension system. **IGNITION SYSTEM**: Battery Ignition system, Magneto Ignition system, electronic Ignition system.	**08 Hours / L1, L2, L3**
Module 5 **HYBRID AND ELECTRIC VEHICLES** Main components and working principles of a hybrid and electric vehicles, Different configurations of hybrid and electric vehicles. Power Split devices for Hybrid Vehicles - Operation modes - Control Strategies for Hybrid Vehicle - Economy of hybrid Vehicles - Case study on specification of electric and hybrid vehicles. **AUTOMOTIVE EMISSION CONTROL SYSTEMS**: Different air pollutants, formation of photochemical smog and causes. Automotive emission controls, Euro I, II, III and IV norms, FAME Policy	**08 Hours / L1, L2, L3**

COURSE OUTCOMES: Upon completion of this course, student will be able to:

CO642.1	Identify the different parts of an automobile and it's working and various lubrication system
CO642.2	Selection and applications of various types of fuels and injection systems.
CO642.3	Describe the working of transmission and braking systems.
CO642.4	Understand the working of steering and suspension systems and their applications.
CO642.5	Identify the Hybrid vehicle systems and study the cause of automobile emissions, its effects on environment and methods to reduce the emissions.

Textbooks:

1. Automobile engineering, **Kirpal Singh**, Vol I and II (12th Edition) Standard Publishers 2011
2. Automotive Mechanics, **S. Srinivasan**, (2nd Edition) Tata McGraw Hill 2003.

Reference books:

1. Automobile Engineering, **R. B. Gupta, Satya Prakashan**,(4th Edition)
2. Fundamentals of Automobile Engineering, **K.K.Ramalingam**, Scitech Publications (India) Pvt. Ltd.

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3. Automotive mechanics, **William H Crouse & Donald L Anglin** (10th Edition) Tata McGraw Hill Publishing
4. Automotive mechanics: Principles and Practices, **Joseph Heitner,** D Van Nostrand Company, Inc

E-Books / Web References

1. **E - Books:** https://www.pdfdrive.com/automotive-engineering-
2. E-Books: https://engineeringbookspdf.com/category/automobile-engineering-books/
3. Web reference: https://pib.gov.in/newsite/PrintRelease.aspx?relid=191377

MOOCs

1. NPTEL Course: "Fundamental of Automotive " https://nptel.ac.in/courses/107106088
2. NPTEL Course: "Injection systems" (https://nptel.ac.in/courses/112103262)
3. MOOC Course: "Braking system", (https://hypersonictech.in/automotive-brake-system/
4. MOOC Course: "Emission control", (https://www.mooc-list.com/tags/carbon-emissions)

Scheme of Examination:

Semester End Examination (SEE):

SEE Question paper is to be set for 100 marks and the marks scored will be proportionately reduced to 50. There will be two full questions (with a maximum of four sub questions) from each module carrying 20 marks each. Students are required to answer any **five full questions** choosing at least **one full question from each module.**

Continuous Internal Evaluation (CIE):

Three Tests are to be conducted for 40 marks each. Average of three tests is taken. CIE is executed by way of one quiz / Alternate Assessment Tools (AATs), and average of three tests. One quiz is conducted and evaluated for 10 marks.

Some possible AATs:

Assignments/ group activity / any other.

Typical Evaluation pattern for regular courses is shown in Table 2.

Table 2: Distribution of weightage for CIE & SEE of Regular courses

	Component	Marks	Total Marks
CIE	CIE Test-1	**40**	**50**
	CIE Test-2	**40**	
	CIE Test-3	**40**	
	Quiz 1/AAT	**10**	
SEE	Semester End Examination	**50**	**50**
Grand Total			**100**

CO/PO Mapping															
CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO642.1	3	1	1			1	1					1	2		
CO642.2	3	1	1			1	1					1	2		
CO642.3	3	1	1			1	1					1	2		
CO642.4	3	1	1			1	1					1	2		
CO642.5	3	1	1			1	1					1	2		
Average	**3**	**1**	**1**			**1**	**1**					**1**	**2**		

Low - 1: Medium - 2: High - 3

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SEMESTER – VI

Course: DESIGN OF TRANSMISSION ELEMENTS

Course Code	**21MED643**	**CIE Marks**	**50**
Hours/Week (L: T: P)	**2 : 2 : 0**	**SEE Marks**	**50**
No. of Credits	**3**	**Examination Hours**	**03**

Prerequisites: Engineering Mechanics, Strength of Materials, Design of Machine Elements.

Course Objectives: The students will be taught:

CO1	To calculate stresses in helical springs and design leaf springs.
CO2	To design flat and V belts, wire ropes, and chains, and understand their performance.
CO3	To design clutches and brakes for automotive systems, focusing on materials and performance
CO4	To design spur and helical gears, focusing on strength and wear.
CO5	To design bevel and worm gears, selecting materials and ensuring efficiency.

Content	No. of Hours/ RBT levels
Module 1 **Helical Springs:** Types of springs, spring materials, stresses in helical coil springs of circular and non-circular cross sections. Tension and compression springs, concentric springs. **Leaf Springs**: Stresses in leaf springs, equalized stresses, nipping of leaf springs. Design of leaf springs.	**10 Hours / L1, L2, L3**
Module 2 **Belts:** Materials of construction of flat and V belts, power rating of belts, concept of slip and creep, initial tension, effect of centrifugal tension, maximum power condition. Selection of flat and V belts- length & cross section from manufacturers' catalogues. **Wire ropes and Chains**: Construction of wire ropes, stresses in wire ropes, and selection of wire ropes, Chains: Types of chains, Selection of roller chains.	**10 Hours / L1, L2, L3**
Module 3 **Design of Clutches:** Necessity of a clutch in an automobile, types of clutch, friction materials and its properties. Design of cone clutch, single plate and multi-plate clutches based on uniform pressure and uniform wear theories. **Design of Brakes:** Different types of brakes, Concept of self-locking of brakes. Practical examples, Design of block brakes, band brakes.	**10 Hours / L1, L2, L3**
Module 4 **Gear drives:** Classification of gears, materials, standard systems of gear tooth **Spur Gears:** Definitions, stresses in gear tooth: Lewis equation and form factor, design for strength, dynamic load and wear. **Helical Gears:** Definitions, transverse and normal module, design based on strength, dynamic load and wear.	**10 Hours / L1, L2, L3**

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Module 5	
Bevel Gears: Definitions, Types of bevel gears, design based on strength, dynamic load and wear. **Worm Gears**: Definitions, materials for worm and worm wheel. Design based on strength, dynamic, wear loads and efficiency of worm gear drives.	**10 Hours / L1, L2, L3**

COURSE OUTCOMES: Upon completion of this course, student will be able to:

CO643.1	Calculate the stresses in helical springs with circular and non-circular cross-sections and apply principles to the design and stress analysis of leaf springs.
CO643.2	Determine the suitable materials, design specifications, and performance parameters for flat and V belts, wire ropes, and chains, including the calculation of power ratings, slip and creep effects, and stress analysis.
CO643.3	Design various types of clutches and brakes while considering friction materials, self-locking concepts for effective power transmission and braking performance in automotive applications.
CO643.4	Design spur and helical gears based on strength, dynamic load, and wear, using Lewis equation and form factors for spur gears and helical gears.
CO643.5	Design bevel gears and worm gears, selecting appropriate materials and applying design principles to ensure strength, minimize dynamic loads and wear, and optimize the efficiency of worm gear drives.

TEXT BOOKS:

1. **Mechanical Engineering Design,** Joseph E Shigley and Charles R.Mischke. McGraw Hill International edition, 6th Edition 2009.
2. **Design of Machine Elements,** V.B. Bhandari, Tata McGraw Hill Publishing Company Ltd., New Delhi, 2nd Edition 2007.

DESIGN DATA HAND BOOK:

1. **Design Data Hand Books, Volume 1 and 2,** K. Lingaiah, McGraw Hill, 2nd Ed.

REFERENCE BOOKS:

1. **Machine Design,** Robert L. Norton, Pearson Education Asia, 2001.
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. **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. **Fundamentals of Machine Component Design,** Robert C. Juvinall and Kurt M Marshek, Wiley India Pvt. Ltd., New Delhi, 3rd Edition, 2007.

WEB/ONLINE REFERENCES

www.nptel.ac.in

MOOCs

1. NPTEL Course: "Design of Machine Elements" http:// https://nptel.ac.in/courses/112/107/112107146/#
2. NPTEL Course: "Strength of Materials" (https://onlinecourses.nptel.ac.in/)
3. MOOC Course: "Machine Design", (https://www.coursera.org/courses?query=mechanics%20of%20materials)
4. Free Video Lectures: "Design of Machine Elements", (https://freevideolectures.com/course/96/)

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Scheme of Examination: (Theory courses)

Semester End Examination (SEE):

SEE Question paper is to be set for 100 marks and the marks scored will be proportionately reduced to 50. There will be two full questions (with a maximum of four sub questions) from each module carrying 20 marks each. Students are required to answer any **five full questions** choosing at least **one full question from each module.**

Continuous Internal Evaluation (CIE):

Three Tests are to be conducted for 50 marks each. The average of the three tests are taken for computation of CIE on a scale of 40. The assignment would be for a total of 10 marks,
CIE is executed by way of two quizzes / Other Assessment Tools (OATs), and three tests.

Some possible methods of assessment for assignments: Assignments / Oral presentations / Group activity / Projects

Typical Evaluation pattern for regular courses is shown in Table 1.

Table 1: Distribution of weightage for CIE & SEE of Regular courses

	Component	Marks	Total Marks
CIE	CIE Test-1	**40**	**50**
	CIE Test-2	**40**	
	CIE Test-3	**40**	
	Assignment	**10**	
SEE	Semester End Examination	**100**	**50**
		Grand Total	**100**

CO/PO Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO643.1	3	2	2	1		1	1			1		2	2		
CO643.2	3	2	2	1		1	1			1		2	2		
CO643.3	3	2	2	1		1	1			1		2	2		
CO643.4	3	2	2	1		1	1			1		2	2		
CO643.5	3	2	2	1		1	1			1		2	2		
Average	**3**	**2**	**2**	**1**		**1**	**1**			**1**		**2**	**2**		

Low - 1: Medium - 2: High – 3

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SEMESTER – VI

Course: Data Analytics

Course Code	21MED644	CIE Marks	50
Hours/Week (L: T: P)	3 : 0 : 0	SEE Marks	50
No. of Credits	3	Examination Hours	03

Prerequisites: Basics of Probability and Statistics

Course Objectives: This course will enable the students to,

CLO1	Provide an overview of the good practice of data visualization.
CLO2	Learn how to navigate Tableau and connect to data sources, leverage drag-and-drop interface to create impactful visualizations.
CLO3	Facilitate project-based opportunities to identify, understand, analyze, prepare, and present effective visualizations on a variety of data.

Content	No. of Hours/ RBT levels
Module 1 **Introduction to Data Science and Analytics:** Basic Terminology in data Science and Analytics, Requirements of Data Science and Analytics, Data Science Venn Diagram, Modeling of Data. **Case study on Automating (Mechanical) Government Paper Pushing, Printing and Marketing Dollars, Firing all Mechanical Engineers – Right or Wrong?**	**08 Hours /L3**
Module 2 **Insight into Data**: Flavors of Data, Structured and Unstructured Data, Qualitative, Quantitative Data, Levels of Data, Discrete and Continuous Data. Data Preprocessing and Post Processing, Measures of Center and Variation. Five Steps in Data Analytics **Case study on Coffee Shop Data, World Soft Drinks Consumption Data, Covid Vaccination Data.**	**08 Hours /L3**
Module 3 **Data Communication:** Identifying effective and ineffective Visualizations. Scatter Plots, Line Graphs, Bar Charts, Histograms, Box Plots, Correlation and Causation of Data, Verbal Communication – Story Telling of Data. Strategy of Presenting. **Data Analytics using Tableau:** History of Tableau, Advantages and disadvantages of Tableau, Tableau architecture, Tableau Public and Tableau Desktop, Terminologies, Data types, Data roles, Data aggregation, File types.	**08 Hours /L3**

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Module 4 **Tableau Training:** Installing Tableau, Create Bar Charts, maps and Pie charts. **Creating Interactive Dashboards,** Understand Types of Joins and how they work, Create Table Calculations, Create Dual Axis Charts, Work with Timeseries Data (two methods), Create Data Hierarchies, Assigning Geographical Roles to Data Elements.	**08 Hours /L3**
Module 5 **Connecting Tableau to Real time Data**: Connect Tableau to various Datasets: Excel and CSV files, Create Area Charts, scatter plots, Tree maps, story lines, Data Blending, Forecasting and Clustering, density Charts.	**08 Hours /L3**

COURSE OUTCOMES: Upon completion of this course, students will be able to

CO644.1	Recognize the significance of Data Analytics in analyzing data for physical significance to real time mechanical data.
CO644.2	Understand the insight into types and classifications of data
CO644.3	Recognize the significance of Data presentation for physical significance to real time mechanical data.
CO644.4	Apply the concepts of data visualization and analysis using tableau
CO644.5	Infer on the data analyzed and derive conclusive results.

Textbooks:

1. **Donatel Santos:** Tableau 10: Business Intelligence Cookbook, 10th edition, 2016.
2. **Dona M Wong:** The Wall Street Journal Guide to Information Graphics: The Do's and Don't's of Presenting Data, facts and Figures, 12th Edition 2021.

Reference books:

1. **Stephen Few**: Information Dashboard Design: Displaying Data for At- a-Glance Monitoring, O'Reilly Media, 2013.

Books / Web References

1. Data Visualization and Exploration with R A Practical Guide to Using R RStudio and Tidyverse for Data Visualization Exploration and Data Science Applications: https://www.pdfdrive.com/data-visualization-and-exploration-with-r-a-practicalguide-to-using-r-rstudio-and-tidyverse-for-data-visualization-exploration-and-datascience-applications-d176184240.html
2. 2. Beginning Data Science in R: Data Analysis, Visualization, and Modelling for the Data Scientist: https://www.pdfdrive.com/beginning-data-science-in-r-data-analysisvisualization-and-modelling-for-the-data-scientist-d181093942.htmlhttps://pm-guide.netguru.com/

MOOCs

1. https://www.coursera.org/learn/datavisualization
2. https://freevideolectures.com/course/4041/nptel-introduction-to-learning-analytics/11
3. https://www.edx.org/course/data-visualization-for-all

Scheme of Examination: (Theory courses)

Semester End Examination (SEE): SEE Question paper is to be set for 100 marks and the marks scored will be proportionately reduced to 50. There will be two full questions (with a maximum of four sub

questions) from each module carrying 20 marks each. Students are required to answer any **five full questions** choosing at least **one full question from each module.**

Continuous Internal Evaluation (CIE): Three Tests are to be conducted for 40 marks each. The average of the three tests are taken for computation of CIE on a scale of 40. CIE is executed by way of two quizzes/Other Assessment Tools (OATs), and three tests. **Some possible AATs:** Assignments / Oral presentations /Group activity/Projects. Typical Evaluation pattern for regular courses shown in Table.

Table 2: Distribution of weightage for CIE & SEE of Regular courses

	Component	Marks	Total Marks
CIE	CIE Test-1	**40**	**50**
	CIE Test-2	**40**	
	CIE Test-3	**40**	
	QUIZ/OAT	**10**	
SEE	Semester End Examination	**100**	**50**
		Grand Total	**100**

CO/PO Mapping															
CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO644.1	2	3	1									2			
CO644.2	2	3	3	3	2							2			
CO644.3	2	3	3	3	2							2			
CO644.4	2	3	3	3	2							2			
CO644.5	2	3	3	3	2							2			
Average	2	3	3	3	2							2			

Low - 1: Medium - 2: High - 3

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SEMESTER – VI

OPEN ELECTIVE 1 (OE1)

Course: Project & Operations Management

Course Code	**21MED651**	**CIE Marks**	**50**
Hours/Week (L: T: P)	**3 : 0 : 0**	**SEE Marks**	**50**
No. of Credits	**3**	**Examination Hours**	**03**

Prerequisites: Management and Entrepreneurship

Course Objectives: This course will enable the students to,

CLO1	To instill Project Management principles and practices to create/develop a unique product, a unique service or capability to perform a service, unique result, such as an outcome or document and/or a unique combination of one or more products, services or results.
CLO2	To inculcate the S.M.A.R.T deliverables of a project and evaluate the impact of these deliverables on the states of nature viz. economic, material, social, and environmental.
CLO3	To elucidate the benefits of Project Management and its applications on business value creation comprising tangible (Monetary assets, Stakeholder equity, Utilities and Market share etc.) and intangible elements (Strategic alignment, Goodwill and Brand recognition etc.).

Content	No. of Hours/ RBT levels
Module 1 **Introduction to Project Management:** Understanding Project Management, Defining the Project Manager's Role, Defining the functional Manager's role, the project manager as the planning agent, Project Sponsor Interface, project Champions, Project Driven v/s Non-project Driven Organizations. Classifications of Projects, Differing views of Project Management, Concurrent Engineering: A project Management approach, informal Project Management Product v/s Project management, Project Life cycles, Many faces of failure.	**08 Hours /L3**
Module 2 **Planning:** Phases of Project Life Cycle: Initiating Process (Engineering Quote Process, The Project Award, Project with a Kick-off), Planning Process (Information Sharing, Development & Updating in Project Plan), Executing Process, Monitoring and Controlling Process and Closing Process. Scope Management: Development of Work Breakdown Structure (WBS) and Resources Management. Estimation of WBS effort.	**08 Hours /L3**
Module 3 **Network Scheduling Techniques:** Network Fundamentals, Slack time, Network planning, estimating total project time, Total PERT/CPM planning, Crashing of Networks, PERT/CPM Numericals.	**08 Hours /L3**

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Module 4 **Project Development Models:** Introduction and Comparison between Waterfall Methodology and Agile Methodology. Waterfall Model: Stages of Waterfall methodology (Requirements, Design, Implementation, verification or testing and Deployment & Maintenance), Prominent Uses of Waterfall Methodology, Advantages and Disadvantages of Waterfall Methodology. **Agile Methodology:** Overview, Agile Manifesto, 3C's of Agile (Card, Conversation and Confirmation), Benefits of Agile Model.	**08 Hours /L3**
Module 5 **Forecasting:** Nature and Use of Forecast, Forecasting Models and methods – Selection of Forecasting Techniques, measures of Forecasting accuracy, simple moving average, weighted moving average, double moving average, simple exponential smoothening, adjusted exponential smoothening, Linear regression method. **Inventory Control**: Inventory Decisions, Costs, Inventory Models.	**08 Hours /L3**

COURSE OUTCOMES: Upon completion of this course, students will be able to

CO651.1	Recognize the significance of Project Management in complex business setups and describe an organized flow structure for effective accomplishment of predetermined objectives of organization.
CO651.2	Understand the Project life cycle processes and construct appropriate action plan for optimizing resources of the underlying project deliverables.
CO651.3	Apply the knowledge of construction of networks and the estimation of time of completion of the project
CO651.4	Distinctively of elaborate the difference between the Waterfall Methodology and Agile Methodology and apply the appropriate Project development models
CO6551.5	Understand the costs and models of forecasting and inventory techniques.

Textbooks:

3. **Harold Kerzner:** Project Management - A Systems Approach to Planning, Scheduling, and Controlling, 10th edition.
4. A Guide to the Project Management Body of Knowledge – Project Management Institute.
5. **Kalpesh Asher:** Project Management and Agile Essentials – A Practical Self-Study Guide, Vibrant Publishers.
6. Pannerselvam, Production and Operations Management – Third Edition, PHI

Reference books:

2. **Mark C. Layton, Steven J. Ostermiller**: Agile Project Management for Dummies.
3. **Prasanna Chandra:** Project Management – Planning & Control, TMH.

E-Books / Web References

3. https://opentextbc.ca/projectmanagement/
4. https://pm-guide.netguru.com/

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MOOCs

4. https://www.edx.org/course/introduction-to-project-management?index=product&search_index=product&webview=false&campaign=Introduction+to+Project+Management&source=edX&product_category=course&placement_url=https%3A%2F%2Fwww.edx.org%2Flearn%2Fproject-management

Scheme of Examination: (Theory courses)

Semester End Examination (SEE):

SEE Question paper is to be set for 100 marks and the marks scored will be proportionately reduced to 50. There will be two full questions (with a maximum of four sub questions) from each module carrying 20 marks each. Students are required to answer any **five full questions** choosing at least **one full question from each module.**

Continuous Internal Evaluation (CIE):

Three Tests are to be conducted for 40 marks each. The average of the three tests are taken for computation of CIE on a scale of 40.

CIE is executed by way of two quizzes / Other Assessment Tools (OATs), and three tests.

Some possible AATs: Assignments / Oral presentations / Group activity/Projects

Typical Evaluation pattern for regular courses is shown in Table 2.

Table 2: Distribution of weightage for CIE & SEE of Regular courses

	Component	Marks	Total Marks
CIE	CIE Test-1	**40**	**50**
	CIE Test-2	**40**	
	CIE Test-3	**40**	
	QUIZ/OAT	**10**	
SEE	Semester End Examination	**100**	**50**
		Grand Total	**100**

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO651.1	2		2	3	3				2	2	3	2
CO651.2	3	3	3	3	1				2	2	3	2
CO651.3	1	3	3	2	1				2	2	3	2
CO651.4		2	3	2					2	2	3	2
CO651.5	2	2		2	2				2	2	3	2
Average	**2**	**3**	**3**	**3**	**2**				**2**	**2**	**3**	**2**

Low - 1: Medium - 2: High - 3

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SEMESTER – VI

Open Elective - I

Course: Quantitative Techniques

Course Code	**21MED652**	**CIE Marks**	**50**
Hours/Week (L: T: P)	**2 : 2 : 0**	**SEE Marks**	**50**
No. of Credits	**3**	**Examination Hours**	**03**

Prerequisites: Basic Mathematics

Course Objectives: The students will be taught to:

CLO1	Convert the real life situations to mathematical form and find optimal solutions.
CLO2	Draw the network showing the flow of activities and determine the completion of project.
CLO3	Predict the characteristics of queues like probability of waiting, waiting times, number of customers etc.

Content	No. of Hours/ RBT levels
Module 1 **Introduction:** Importance, scope, techniques and characteristics of Optimization concept, Linear Programming- Formulation of LP problems and solution by graphical method.	**08 Hours / L1, L2, L3**
Module 2 **Solution to LPP:** Simplex method, Big-M method, Degeneracy- resolving degeneracy, Duality-	**08 Hours / L1, L2, L3**
Module 3 **Transportation Models:** Importance, terminologies used, different methods for finding Initial basic feasible solution; NWCM, LCM and VAM, unbalanced, degeneracy in transportation, test for optimality, maximization problems. **Assignment Models:** Hungarian method for solving Assignment problems, balanced, unbalanced, restricted assignments.	**08 Hours / L1, L2, L3**
Module 4 **Sequencing:** Assumptions of job scheduling, Different models of sequencing models processing 'n' jobs through 2 machines, processing of jobs on 3 machines, processing 'n' jobs on 'm' machines, processing of 2 jobs on m machines **Queuing Theory:** Introduction, Characteristics of Queueing systems, Representation of Queueing models by Kendal's Notation, Numericals on M/M/1 models only.	**08 Hours / L1, L2, L3**
Module 5 **Network analysis:** Differences between PERT and CPM, Network construction, Node numbering using Fulkerson's rule, Determination of critical path and duration, floats, CPM –Prediction of project completion **Game Theory:** Definitions of terminologies used in Game theory, Formulation of payoff matrix, Maximin and Minimax principles for Games of Pure strategy, Algebraic method for games of mixed strategy, Graphical method to solve 2xn and mx2 games, Dominance	**08 Hours / L1, L2, L3**

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principle for mxn games.	

COURSE OUTCOMES: Upon completion of this course, student will be able to:

CO652.1	Formulate real-life problems using concepts Linear Programming and obtain the optimum solutions.
CO652.2	Formulate real-life transportation and assignment problems to find the optimum solution.
CO652.3	Construct the precedence diagram to find the duration of project.
CO652.4	Formulate the competitive situations to find the winner of the game.
CO652.5	Analyze the Queueing model for satisfaction of customer.
CO652.6	Determine the sequence of jobs so as to minimize the total elapsed time for completion.

Textbooks:

1. **J. K. Sharma:** Operations Research: Theory and Applications, Macmillan, 4/e, 2009
2. **Taha, H.** 2007. Operations Research – An Introduction, 8th Edition, Prentice Hall, India, ISBN: 9780131889230

Reference books:

1. **Kalavathy S** : Operations Research, 3/e, Vikas Publishing House.
2. **A M Natarajan, P Balasubramani,** Operations Research, Pearson Education, 2005

E-Books / Web References

1. https://www.bbau.ac.in/dept/UIET/EME-601%20Operation%20Research.pdf
2. https://www.pdfdrive.com/introduction-to-operations-research-d14995994.html

MOOCs

1. https://nptel.ac.in/courses/110106062
2. https://nptel.ac.in/courses/111107128

Scheme of Examination:

Semester End Examination (SEE):

SEE Question paper is to be set for 100 marks and the marks scored will be proportionately reduced to 50. There will be two full questions (with a maximum of four sub questions) from each module carrying 20 marks each. Students are required to answer any **five full questions** choosing at least **one full question from each module.**

Continuous Internal Evaluation (CIE):

Three Tests are to be conducted for 40 marks each. CIE is executed by way of three tests and a quiz / Alternate Assessment Tools (AATs) for 10 marks.

Some possible AATs:

Assignments/ group activity / any other.

Typical Evaluation pattern for regular courses is shown in Table 2.

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Table 2: Distribution of weightage for CIE & SEE of Regular courses

	Component	Marks	Total Marks
CIE	CIE Test-1	**40**	**50**
	CIE Test-2	**40**	
	CIE Test-3	**40**	
	Quiz /AAT	**10**	
SEE	Semester End Examination	**50**	**50**
Grand Total			**100**

CO/PO Mapping												
CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO652.1	2	2				1						
CO652.2	2	2				1						1
CO652.3	2	2				1					2	
CO652.4	2	2				1						
CO652.5	2	2				1						1
CO652.6	2	2				1						1
Average	2	2				1					2	1

Low - 1: Medium - 2: High – 3

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SEMESTER – VI

Course: Ability Enhancement Course – III: CNC Technology

Course Code	21MED66	CIE Marks	50
Hours/Week (L: T: P)	0 : 0 : 2	SEE Marks	50
No. of Credits	1	Examination Hours	03

Course Objectives: To enable students to apply the knowledge CNC Technology in broad domain of mechanical engineering by making them to learn:

CLO1	Fundamentals of CNC Machines and its construction
CLO2	Programming CNC machine operated on FANUC Controller
CLO3	Operation of CNC Turning center

Content	No. of Hours/ RBT levels
Module 1 **Fundamentals of CNC Technology** Fundamentals of CNC Machines, Construction, Machining Operations and sequence, Cutting Tools, Cutting Parameters, Work and Tool holding devices, Reading Part Drawing **CNC Turning Programming** Programming Concepts, G & M Codes, Canned Cycles, Programming Syntax, Tool Path	**12 Hours / L3**
CNC Turning Machine Setting & Operating CNC System console operation, MDI & Jog Modes, Work Offsets and Tool offsets, mounting cutting tools, manual entry of CNC part programs, single block check for errors and tool collisions and auto mode operation.	**12 Hours / L3**

COURSE OUTCOMES: Upon completion of this course, student will be able to:

CO66.1	Develop part programming using G- and M- codes
CO66.2	Set up the CNC machining center for manufacturing
CO66.3	Produce the parts on CNC Turning Machine

Textbooks:

1. Automation, Production Systems and Computer-Integrated Manufacturing, by Mikell P Groover, 4th Edition, 2015, Pearson Learning.
2. CAD / CAM Principles and Applications by P N Rao, 3rd Edition, 2015, Tata McGraw-Hill.

CO/PO Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO66.1	3	2	2	-	-	-	-	-	-	-	-	3	3	-	-
CO66.2	3	-	-	-	3	2	2	-	-	-	-	3	3	-	-
CO66.3	3	-	-	-	3	-	-	-	-	3	-	3	3	-	-
Average	**3**	**2**	**2**	**-**	**3**	**2**	**2**	**-**	**-**	**3**	**-**	**3**	**3**	**-**	**-**

Low - 1: Medium - 2: High – 3

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SEMESTER – V/VI

Course: Environmental Science

Course Code	21CIV57/67	CIE Marks	50
Hours/Week (L: T: P)	1:0:0	SEE Marks	50
No. of Credits	1	Examination Hours	1 hour

Course Learning Objectives:

CLO1	The fundamentals of environmental science.
CLO2	The types of natural resources
CLO3	The various global environmental concerns.
CLO4	The types of wastes generated and their handling at a basic level
CLO5	The area of environmental law and policies with a few important acts in the field

Content	No. of Hours/ RBT Levels
Module 1 **Environment:** • Definition, scope & importance • Components of Environment Ecosystem: Structure and function of various types of ecosystems • Human Activities – Food, Shelter, and Economic & Social Security. • Population - Growth, variation among nations – population explosion and impact on environment **Biodiversity:** Types, Value; Hot spots; Threats and Conservation of biodiversity, Forest Wealth, and Deforestation.	**04 Hours / L2**
Module 2 **Natural Resources**: Forest, Water, Mineral, Food, Energy, Land Environmental Pollution - Definition – causes, effects and control measures of: (a) Air pollution (b) Water pollution (c) Soil pollution (d) Marine pollution (e) Noise pollution (f) Thermal pollution (g) Nuclear hazards.	**04 Hours / L2**
Module 3 **Global Environmental Concerns** (Concept, policies and case-studies): Ground water depletion/recharging, Climate Change; Acid Rain; Ozone Depletion; Radon and Fluoride problem in drinking water; Resettlement and rehabilitation of people, Environmental Toxicology.	**04 Hours / L2**
Module 4 **Sources:** Sources of Solid waste, Types of solid waste, Physical and Chemical composition of municipal solid waste. Solid Waste Management Rules in India Sources and management of E – Waste, Biomedical Waste, Hazardous waste, and construction waste at individual and community level. Socio-economic aspect of waste management Environmental Toxicology.	**04 Hours / L2**
Module 5 **Latest Developments in Environmental Pollution Mitigation Tools** (Concept and Applications): Environment Impact Assessment, Environmental Management Systems, ISO14001; Environmental Stewardship, NGOs.	**04 Hours / L2**

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COURSE OUTCOMES: Upon completion of this course, student will be able to:

21CIV57.1/67.1	Understand holistically the key concepts "Environment", and "Biodiversity".
21CIV57.2/67.2	Classify the types of natural resources available and the effects of anthropogenic interventions.
21CIV57.3/67.3	Express the gravity of various global environmental concerns.
21CIV57.4/67.4	Categorize the types of wastes generated and their handling at a basic level.
21CIV57.5/67.5	Understand the importance of environmental law and policies.

Textbooks:

1. Environmental studies, Benny Joseph, Tata Mcgraw-Hill 2nd edition 2012
2. Environmental studies, S M Prakash, pristine publishing house, Mangalore 3rd edition
3. Gilbert M.Masters, Introduction to Environmental Engineering and Science, 2nd edition, Pearson Education, 2004

Reference books:

1. Benny Joseph, Environmental studies, Tata Mcgraw-Hill 2nd edition 2009
2. M.Ayi Reddy Textbook of Environmental Science and Technology, BS publications 2007
3. Dr. B.S Chauhan, Environmental Studies, University of science press 1st edition

Web References:

https://www.hzu.edu.in/bed/E%20V%20S.pdf

https://onlinecourses.nptel.ac.in/noc23_hs155/preview

https://onlinecourses.swayam2.ac.in/cec19_bt03/preview

Scheme of Examination: Semester End Examination (SEE): SEE Question paper is to be set for 50 marks with multiple choice questions of 1 mark each covering all aspects of the syllabus.

Continuous Internal Evaluation (CIE): Three Tests are to be conducted for 50 marks each. The average of the three tests are taken for computation of CIE. Question paper for each of the CIE is to be of the multiple-choice type with 50 question each.

Table 1: Distribution of weightage for CIE & SEE for 1 credit course

	Component	Marks	Total Marks
CIE	CIE Test-1	**50**	**50**
	CIE Test-2	**50**	
	CIE Test-2	**50**	
SEE	Semester End Examination	**50**	**50**
		Grand Total	**100**

CO/PO Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
21CIV57.1/67.1	2	-	-	-	-	-	3	-	-	-	-	-	1	-	-
21CIV57.2/67.2	2	1	-	-	-	-	3	-	-	-	-	1	1	-	1
21CIV57.3/67.3	2	-	2	-	-	2	3	1	-	-	-	1	1	-	1
21CIV57.4/67.4	2	2	-	-	-	2	3	-	-	-	-	-	-	-	1
21CIV57.5/67.5	2	-	-	-	-	2	3	-	-	-	-	-	-	1	1
Average	**2**	**1.5**	**2**	**-**	**-**	**2**	**3**	**1**	**-**	**-**	**-**	**1**	**1**	**1**	**1**

Low-1: Medium-2: High-3

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SEMESTER – V/VI

Course: Universal Human Values

Course Code	21UHV57/67	CIE Marks	50
Hours/Week (L: T: P)	1:0:0	SEE Marks	50
No. of Credits	1	Examination Hours	1 hour

Course Learning Objectives:

CLO1	To create an awareness on Engineering Ethics and Human Values.
CLO2	To understand social responsibility of an engineer.
CLO3	To appreciate ethical dilemma while discharging duties in professional life.

Content	No. of Hours
Module 1 **Introduction to Value Education** • Value Education, Definition, Concept and Need for Value Education. • The Content and Process of Value Education. • Basic Guidelines for Value Education, • Self-exploration as a means of Value Education. • Happiness and Prosperity as parts of Value Education.	**05 Hours**
Module 2 **Harmony in the Human Being** • Human Being is more than just the Body. • Harmony of the Self ('I') with the Body. • Understanding Myself as Co-existence of the Self and the Body. • Understanding Needs of the Self and the needs of the Body. • Understanding the activities in the Self and the activities in the Body.	**05 Hours**
Module 3 **Harmony in the Family and Society and Harmony in the Nature** • Family as a basic unit of Human Interaction and Values in Relationships. • The Basics for Respect and today's Crisis: Affection, Guidance, Reverence, Glory, Gratitude and Love, • Comprehensive Human Goal: The Five Dimensions of Human Endeavour. • Harmony in Nature: The Four Orders in Nature. • The Holistic Perception of Harmony in Existence.	**05 Hours**
Module 4 **Social Ethics** • The Basics for Ethical Human Conduct, Defects in Ethical Human Conduct. • Holistic Alternative and Universal Order, • Universal Human Order and Ethical Conduct. • Human Rights violation and Social Disparities.	**05 Hours**
Module 5 **Professional Ethics** • Value based Life and Profession., Professional Ethics and Right Understanding. • Competence in Professional Ethics. • Issues in Professional Ethics – The Current Scenario. • Vision for Holistic Technologies • Production System and Management Models.	**05 Hours**

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COURSE OUTCOMES: Upon completion of this course, student will be able to:

21UHV57.1/67.1	Understand the significance of value inputs in a classroom and start applying them intheir life and profession
21UHV57.2/67.2	Distinguish between values and skills, happiness and accumulation of physical facilities,the Self and the Body, Intention and Competence of an individual, etc.
21UHV57.3/67.3	Understand the role of a human being in ensuring harmony in society and nature.
21UHV57.4/67.4	Distinguish between ethical and unethical practices and start working out the strategy toactualize a harmonious environment wherever they work.

Textbooks:

1. A.N Tripathy, New Age International Publishers, 2003.
2. Bajpai. B. L, New Royal Book Co, Lucknow, Reprinted, 2004
3. Bertrand Russell Human Society in Ethics & Politics

Reference books:

1. Jeevan Vidya: Ek Parichaya, A Nagaraj, Jeevan Vidya Prakashan, Amarkantak, 1999.
2. Human Values, A.N. Tripathi, New Age Intl. Publishers, New Delhi, 2004.
3. Corliss Lamont, Philosophy of Humanism.
4. Gaur. R.R. , Sangal. R, Bagari G.P, A Foundation Course in Value Education,Excel Books, 2009.
5. Gaur. R.R. , Sangal R , Bagaria G.P, Teachers Manual, Excel Books, 2009.
6. I.C. Sharma, Ethical Philosophy of India, Nagin & co, Julundhar
7. William Lilly- Introduction to Ethics -Allied Publisher

Scheme of Examination:

Semester End Examination (SEE): SEE Question paper is to be set for 50 marks with multiple choice questions of 1 mark each covering all aspects of the syllabus.

Continuous Internal Evaluation (CIE): Three Tests are to be conducted for 50 marks each. The average of the three tests are taken for computation of CIE. Question paper for each of the CIE is to be of the multiple-choice type with 50 question each. Typical Evaluation pattern for regular courses is shown in Table.

Table 1: Distribution of weightage for CIE & SEE for 1 credit course

	Component	Marks	Total Marks
CIE	CIE Test-1	**50**	**50**
	CIE Test-2	**50**	
	CIE Test-3	**50**	
SEE	Semester End Examination	**50**	**50**
		Grand Total	**100**

CO/PO Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
21UHV57.1/67.1	-	-	-	-	-	-	-	2	-	-	-	1	-	-	-	-
21UHV57.2/67.2	-	-	-	-	-	-	-	2	-	-	-	1	-	-	-	-
21UHV57.3/67.3	-	-	-	-	-	-	-	2	-	-	-	1	-	-	-	-
21UHV57.4/67.4	-	-	-	-	-	-	-	2	-	-	-	1	-	-	-	-
Average	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**-**	**-**	**-**	**1**	**-**	**-**	**-**	**-**

Low-1: Medium-2: High-3

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SEMESTER – VI

Course: Mini-Project

Course Code	21MPT68	CIE Marks	50
Hours/Week (L: T: P)	0 : 0 : 4	SEE Marks	50
No. of Credits	2	Examination Hours	3

Mini-project work:
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 senior faculty members of the Department, one of whom shall be 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 in the ratio 50:25:25. The marks awarded for the project report shall be the same for all the batch mates.
(ii) Interdisciplinary: Continuous Internal Evaluation shall be group wise at the college level with the participation of all the guides of the college. 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 in the ratio 50:25:25. The marks awarded for the project report shall be the same for all the batchmates.

SEE for Mini-Project:
(i) Single discipline: Contribution to the Mini-project and the performance of each group member shall be assessed individually in the semester end examination (SEE) conducted at the department.
(ii) Interdisciplinary: Contribution to the Mini-project and the performance of each group member shall be assessed individually in semester end examination (SEE) conducted separately at the departments to which the student/s belong to.

Typical Evaluation pattern for regular courses is shown in Table 2.

Table 2: Distribution of weightage for CIE & SEE of Regular courses

	Component	Marks	Total Marks
CIE	Review-1	-	50
	Review-2	50	
SEE	Semester End Examination	50	50
Grand Total			100

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VII - VIII SEMESTER
SCHEME AND SYLLABUS
Department of
MECHANICAL ENGINEERING

Global Academy of Technology
(Autonomous Institution Affiliated to VTU)
Scheme of UG Autonomous Program – 2021 Batch

VII SEMESTER

Sl. No.	Course Code	Course Title	Course Type	Teaching Dept.	Teaching Hours/Week			Examination			CREDITS
					L	T	P	CIE	SEE	Total	
1	21MED71	Project & Operations Management	PC	Respective Department	3	0	0	50	50	100	3
2	21MED72	Advanced Manufacturing Systems (Integrated)	IPC		3	0	2	50	50	100	4
3	21MED73	Smart Materials & MEMS	PC		3	0	0	50	50	100	3
4	21MED74X	Program Elective 3	PEC		3	0	0	50	50	100	3
5	21MED75X	Open Elective 2	OEC	Respective Offering Department	3	0	0	50	50	100	3
6	21MED76	Project Phase 1	MP	Two Contact hours per week				100	-	100	2
7	21MEDL77	Design & Simulation Laboratory	PC	Respective Department	0	0	2	50	50	100	1
							TOTAL	**400**	**300**	**700**	**19**

VIII SEMESTER

Sl. No.	Course Code	Course Title	Course Type	Teaching Dept.	Teaching Hours/Week			Examination			CREDITS
					L	T	P	CIE	SEE	Total	
1	21MED81X	Program Elective 4	PEC	Respective Department	3	0	0	50	50	100	3
2	21MED82X	Program Elective 5	PEC		3	0	0	50	50	100	3
3	21MED83	Project work phase – II	MP	Two Contact hours per week				50	50	100	12
4	21MED84	Technical Seminar	MP	One Contact hours per week				100	--	100	1
5	21MED85	Internship	INT	Completed during the intervening period of VI and VII Semester				50	50	100	2
							TOTAL	**300**	**200**	**500**	**21**

Program Elective & Open Elective

Professional Elective - 3		
Sl. No.	**Course Code**	**Course Title**
1	21MED741	Control Engineering
2	21MED742	Refrigeration & Air Conditioning
3	21MED743	Composite Material Technology
4	21MED744	Total Quality Management
Professional Elective - 4		
Sl. No.	**Course Code**	**Course Title**
1	21MED811	Renewable Energy Technologies
2	21MED812	Thermal Management of Electronic Equipment's
3	21MED813	Operations Research
4	21MED814	Supply Chain Management
Professional Elective - 5		
Sl. No.	**Course Code**	**Course Title**
1	21MED821	Tribology
2	21MED822	Computational Fluid Dynamics
3	21MED823	Industry 4.0
4	21MED824	Non-Traditional Machining

Open Elective - 2		
Sl. No.	**Course Code**	**Course Title**
1	21MED751	Additive Manufacturing
2	21MED752	Supply Chain Management

VII SEMESTER

SYLLABUS

SEMESTER – VII

Course: Project & Operations Management

Course Code	21MED71	CIE Marks	50
Hours/Week (L: T: P)	3 : 0 : 0	SEE Marks	50
No. of Credits	3	Examination Hours	03

Prerequisites: Management and Entrepreneurship

Course Objectives: This course will enable the students to,

CLO1	To instill Project Management principles and practices to create/develop a unique product, a unique service or capability to perform a service, unique result, such as an outcome or document and/or a unique combination of one or more products, services or results.
CLO2	To inculcate the S.M.A.R.T deliverables of a project and evaluate the impact of these deliverables on the states of nature viz. economic, material, social, and environmental.
CLO3	To elucidate the benefits of Project Management and its applications on business value creation comprising tangible (Monetary assets, Stakeholder equity, Utilities and Market share etc.) and intangible elements (Strategic alignment, Goodwill and Brand recognition etc.).

Content	No. of Hours/ RBT levels
Module 1 **Introduction to Project Management:** Understanding Project Management, Defining the Project Manager's Role, Defining the functional Manager's role, the project manager as the planning agent, Project Sponsor Interface, project Champions, Project Driven v/s Non-project Driven Organizations. Classifications of Projects, Differing views of Project Management, Concurrent Engineering: A project Management approach, informal Project Management Product v/s Project management, Project Life cycles, Many faces of failure.	**08 Hours /L3**
Module 2 **Planning:** Phases of Project Life Cycle: Initiating Process (Engineering Quote Process, The Project Award, Project with a Kick-off), Planning Process (Information Sharing, Development & Updating in Project Plan), Executing Process, Monitoring and Controlling Process and Closing Process. Scope Management: Development of Work Breakdown Structure (WBS) and Resources Management. Estimation of WBS effort.	**08 Hours /L3**
Module 3 **Network Scheduling Techniques:** Network Fundamentals, Slack time, Network planning, estimating total project time, Total PERT/CPM planning, Crashing of Networks, PERT/CPM Numericals.	**08 Hours /L3**

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Module 4 **Project Development Models:** Introduction and Comparison between Waterfall Methodology and Agile Methodology. Waterfall Model: Stages of Waterfall methodology (Requirements, Design, Implementation, verification or testing and Deployment & Maintenance), Prominent Uses of Waterfall Methodology, Advantages and Disadvantages of Waterfall Methodology. **Agile Methodology:** Overview, Agile Manifesto, 3C's of Agile (Card, Conversation and Confirmation), Benefits of Agile Model.	**08 Hours /L3**
Module 5 **Forecasting:** Nature and Use of Forecast, Forecasting Models and methods – Selection of Forecasting Techniques, measures of Forecasting accuracy, simple moving average, weighted moving average, double moving average, simple exponential smoothening, adjusted exponential smoothening, Linear regression method. **Inventory Control**: Inventory Decisions, Costs, Inventory Models.	**08 Hours /L3**

COURSE OUTCOMES: Upon completion of this course, students will be able to

CO71.1	Recognize the significance of Project Management in complex business setups and describe an organized flow structure for effective accomplishment of predetermined objectives of organization.
CO71.2	Understand the Project life cycle processes and construct appropriate action plan for optimizing resources of the underlying project deliverables.
CO71.3	Apply the knowledge of construction of networks and the estimation of time of completion of the project
CO71.4	Distinctively of elaborate the difference between the Waterfall Methodology and Agile Methodology and apply the appropriate Project development models
CO71.5	Understand the costs and models of forecasting and inventory techniques.

Textbooks:

1. **Harold Kerzner:** Project Management - A Systems Approach to Planning, Scheduling, and Controlling, 10th edition.
2. A Guide to the Project Management Body of Knowledge – Project Management Institute.
3. **Kalpesh Asher:** Project Management and Agile Essentials – A Practical Self-Study Guide, Vibrant Publishers.
4. Pannerselvam, Production and Operations Management – Third Edition, PHI

Reference books:

1. **Mark C. Layton, Steven J. Ostermiller**: Agile Project Management for Dummies.
2. **Prasanna Chandra:** Project Management – Planning & Control, TMH.

E-Books / Web References

1. https://opentextbc.ca/projectmanagement/
2. https://pm-guide.netguru.com/

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MOOCs

1. https://www.edx.org/course/introduction-to-project-management?index=product&search_index=product&webview=false&campaign=Introduction+to+Project+Management&source=edX&product_category=course&placement_url=https%3A%2F%2Fwww.edx.org%2Flearn%2Fproject-management

Scheme of Examination: (Theory courses)

Semester End Examination (SEE):

SEE Question paper is to be set for 100 marks and the marks scored will be proportionately reduced to 50. There will be two full questions (with a maximum of four sub questions) from each module carrying 20 marks each. Students are required to answer any **five full questions** choosing at least **one full question from each module.**

Continuous Internal Evaluation (CIE):

Three Tests are to be conducted for 40 marks each. The average of the three tests are taken for computation of CIE on a scale of 40.

CIE is executed by way of two quizzes / Other Assessment Tools (OATs), and three tests.

Some possible AATs: Assignments / Oral presentations / Group activity/Projects

Typical Evaluation pattern for regular courses is shown in Table 2.

Table 2: Distribution of weightage for CIE & SEE of Regular courses

	Component	Marks	Total Marks
CIE	CIE Test-1	**40**	**50**
	CIE Test-2	**40**	
	CIE Test-3	**40**	
	QUIZ/OAT	**10**	
SEE	Semester End Examination	**100**	**50**
		Grand Total	**100**

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO71.1	2	1	2	3	3					2	3	2			2
CO71.2	3	3	3	3	1					2	3	2			2
CO71.3	2	3	3	2	1					2	3	2			2
CO71.4	2	2	3	2	1					2	3	2			2
CO71.5	2	2	2	2	2					2	3	2			2
Average	**2**	**3**	**3**	**3**	**2**					**2**	**3**	**2**			**2**

Low - 1: Medium - 2: High - 3

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SEMESTER – VII

Course: ADVANCED MANUFACTURING SYSTEMS (Integrated)

Course Code	21MED72	CIE Marks (Theory + Lab)	30 + 20 = 50
Hours/Week (L: T: P)	3 : 0 : 2	SEE Marks	50
No. of Credits	4	Examination Hours	03

Prerequisites: Elements of Mechanical Engineering

Course Objectives: This course will enable the students to:

CLO1	Impart knowledge of CIM and Automation and different concepts of automation by developing mathematical models.
CLO2	Make students to understand working of automated flow lines with ad without storage buffers.
CLO3	Expose students to automated flow lines, assembly lines, Line Balancing Techniques, and Flexible Manufacturing Systems.
CLO4	Expose students to computer aided process planning, material requirement planning, capacity planning etc.
CLO5	Expose the students to CNC Machine Tools, CNC part programming and CNC machine elements

Content	No. of Hours/ RBT levels
Module 1 **Introduction to CIM and Automation:** Automation in Production Systems, types of layouts, types of automation, reasons for automation, automation principles and strategies, Computer Integrated Manufacturing, computerized elements of a CIM system, CAD/CAM and CIM, **Mathematical models and metrics:** Production rate, Production capacity, utilization, and availability, manufacturing lead time, work-in- process, numerical problems.	**10 Hours / L3**
Module 2 **Automated Production Lines and Assembly Systems:** Fundamentals, system configurations, applications, automated flow lines, buffer storage, control of production line, analysis of transfer lines, analysis of flow lines without storage, partial automation, analysis of automated flow lines with storage buffer, fundamentals of automated assembly systems, numerical.	**10 Hours / L3**
Module 3 **Line Balancing:** Line balancing algorithms, methods of line balancing, numerical problems on largest candidate rule, Kilbridge and Wester method, and Ranked Positional Weights method, Mixed Model line balancing, computerized line balancing methods **Flexible Manufacturing Systems:** Fundamentals of Group Technology and Flexible Manufacturing Systems, types of FMS, FMS components, Material handling and storage system, applications, benefits, computer control systems, FMS planning and design issues, Automated Storage and Retrieval Systems, AS/RS and Automatic parts identification systems and data capture.	**10 Hours / L3**

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Module 4 **Computer Aided Process Planning**: Process Planning, Retrieval and Generative CAPP Systems, benefits of CAPP, Production Planning and Control Systems, typical activities of PPC System, Material Requirement Planning, structure of MRP, inputs and outputs of MRP, benefits, Capacity Planning **Computer Numerical Control:** Introduction, components of CNC, CNC Machine Elements: Guide ways and types: Friction guideways, Antifriction Linear Motion (LM) guideways, Frictionless guideways – Hydrostatic and Aerostatic guideways, Bearings: Hydrostatic bearings, hydrodynamic bearings, antifriction bearings. Re-circulating ball screws.	**10 Hours / L3**
Module 5 **Cutting tool materials** – HSS, Carbides, Ceramics, CBN, PCD, classification of inserts PMK, NSH, qualified, semi qualified and preset tooling, tooling system for CNC Machining centre and Turning centre, Automatic Tool changers, work holding devices for rotating and fixed work parts, Automatic Pallet changer, economics of CNC, maintenance of CNC machines. Feedback devices **CNC Programming** CNC programming, manual part programming, G Codes, M Codes, programming of simple components in milling systems, programming with canned cycles.	**10 Hours / L3**

Laboratory Exercises:

1. Programming of Vertical Machining Centre (Manual programming + Simulation)
    a. Face milling
    b. Slotting
    c. Pocketing
    d. Drilling
    e. Tapping
2. Operating Vertical Machining Center
    a. Loading the workpiece and tools
    b. Offsets
    c. Machine maintenance
    d. Loading and editing the program
    e. Developing the part as per given specifications

COURSE OUTCOMES: Upon completion of this course, student will be able to:

CO72.1	Describe types of production systems and types of automation, mathematical models in production systems.
CO72.2	Determine the line efficiency of an automated production line using upper bound and lower bound approaches with and without storage buffers
CO72.3	Determine the balance delay and balance of flexible manufacturing systems, material handling and storage systems used in production systems
CO72.4	Explain the applications of computers in process planning (CAPP) and numerical control (CNC)
CO72.5	Analyze the performance of different cutting tool materials and evaluate and address maintenance and economic factors to enhance manufacturing efficiency and effectiveness.
CO72.6	Develop CNC Programs for milling components using canned cycles.

Textbooks:

1. Automation, Production Systems and Computer-Integrated Manufacturing, by Mikell P Groover, 4th Edition, 2015, Pearson Learning.
2. CAD / CAM Principles and Applications by P N Rao, 3rd Edition, 2015, Tata McGraw-Hill.
3. Industry 4.0: The Industrial Internet of Things by Alasdair Gilchrist, A Press, 1st Edition, 2016.

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Reference books:

1. CAD/CAM" by Ibrahim Zeid, Tata McGraw Hill.

2. Industry 4.0: The Industrial Internet of Things, Apress, 2017, by Alasdair Gilchrist

3. Computer Integrated Manufacturing by James A. Rehg, Henry W Kraebber , Pearson, 3rd Edition, 2017

E-Books / Web References

1. https://freevideolectures.com/course/3193/advanced-manufacturing-processes
2. https://freevideolectures.com/course/2367/industrial-engineering
3. https://freevideolectures.com/course/2367/industrial-engineering/24
4. https://freevideolectures.com/course/2367/industrial-engineering/27
5. https://freevideolectures.com/course/2367/industrial-engineering/28
6. https://freevideolectures.com/course/2367/industrial-engineering/36
7. https://freevideolectures.com/course/2367/industrial-engineering/37

MOOCs

1. https://onlinecourses.nptel.ac.in/noc22_me10/preview
2. https://www.classcentral.com/course/swayam-computer-integrated-manufacturing-17550

Scheme of Examination: (Integrated courses)

Semester End Examination (SEE): SEE Question paper is to be set for 100 marks and the marks scored will be proportionately reduced to 50. There will be two full questions (with a maximum of four sub questions) from each module carrying 20 marks each. Students are required to answer any **five full questions** choosing at least **one full question from each module.** ***Note: The laboratory assessment would be restricted to only the CIE evaluation.***

Continuous Internal Evaluation (CIE): Three Tests are to be conducted for 40 marks each. The average of the three tests are taken for computation of CIE on a scale of 30, the CIE would also include laboratory evaluation for 20 marks. The laboratory marks of 20 would comprise of 10 marks for regular laboratory assessment to include lab record and observation. 10 marks would be exclusive for laboratory internal assessment test to be conducted at the end of the semester. Typical Evaluation pattern for integrated courses is shown in the Table below

Table: Distribution of weightage for CIE & SEE of Integrated courses

	Component	Marks	Total Marks
CIE	CIE Test-1	**30**	**50**
	CIE Test-2	**30**	
	CIE Test-3	**30**	
	Laboratory	**20**	
SEE	Semester End Examination	**100**	**50**
		Grand Total	**100**

CO/PO Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO72.1	3	2	2	-	-	-	-	-	2	-	-	2	-	-	3
CO72.2	3	2	2	2	-	-	-	-	2	-	-	2	-	-	3
CO72.3	3	2	2	-	-	-	-	-	2	-	-	2	-	-	3
CO72.4	3	2	2	-	-	2	-	-	2	-	-	2	-	-	3
CO72.5	3	2	2	-	-	-	-	-	2	-	-	2	-	-	3
CO72.6	3	2	2	-	3	2	-	2	2	2	-	2	-	-	3
Average	3	2	2	2	3	2	-	2	2	2	-	2	-	-	3

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SEMESTER – VII

Course: SMART MATERIALS and MEMS

Course Code	21MED73	CIE Marks	50
Hours/Week (L: T: P)	3 : 0 : 0	SEE Marks	50
No. of Credits	3	Examination Hours	03

Prerequisites: Material Science and Basic Electronics

Course Objectives: This course will enable the students to:

CLO1	Gain knowledge of smart materials, piezoelectric materials structures, and its characteristics.
CLO2	Understand smart structures and modelling which helps in Vibration control using smart materials for various applications.
CLO3	Analyze the properties of smart structures, MEMS, with the applications and select suitable procedure for fabrication.
CLO4	Understand the principles and concepts of using MEMS, ER & MR Fluids for various applications.

Content	No. of Hours/ RBT levels
Module 1 **Introduction:** Closed loop and Open loop Smart Structures. Applications of Smart structures, Piezoelectric properties. Inchworm Linear motor, Shape memory alloys, Shape memory effect-Application, Processing, and characteristics. **Shape Memory Alloys:** Introduction, Phenomenology, Modelling of shape memory effect.	**08 / L2**
Module 2 **Electro Rheological and Magneto Rheological Fluids**: Mechanisms and Properties, Characteristics, Fluid composition and behavior. **Discovery and Early developments:** Summary of material properties. Applications of ER and MR fluids.	**08 / L2**
Module 3 **Biomimetics:** Characteristics of Natural structures. Fiber reinforced organic matrix natural composites, Natural creamers, Mollusks. Biomimetic sensing, Challenges, and opportunities.	**08 / L2**
Module 4 **MEMS**: History of MEMS, Intrinsic Characteristics, Devices: Sensors and Actuators. Microfabrication: Photolithography, Thermal oxidation, thin film deposition, etching types, Doping, Dicing, Bonding surface microfabrication, Bulk microfabrication, LIGA technique.	**08 / L2**
Module 5 **Polymer MEMS & Microfluidics:** Introduction, Polymers in MEMS Polyimide, SU-8, LCP, PDMS, PMMA, Parylene, Others. Applications (Acceleration, Pressure, Flow, Tactile sensors). Motivation for micro fluidics. **Case Studies:** MEMS Magnetic actuators, BP sensors, Microphone.	**08 / L2**

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COURSE OUTCOMES: Upon completion of this course, student will be able to:

CO73.1	**Analyze** the properties, uses, and design of smart structures and shape memory materials.
CO73.2	**Examine** and compare the mechanisms and applications of ER and MR fluids and **describe** the types and uses of fiber optic sensors.
CO73.3	**Compare** different vibration absorbers and describe the characteristics of natural materials like wood, ceramics, bones, and mollusks.
CO73.4	**analyze** various microfabrication techniques and **assess** the effectiveness of sensing and actuation methods involving magnetization and piezoelectricity through detailed case studies.
CO73.6	**Compare** different fabrication techniques and evaluate case studies of MEMS devices such as pressure sensors, microphones, accelerometers, and gyroscopes to understand their practical impacts and innovations.

Textbooks:

1. "Smart Structures –Analysis and Design", A.V.Srinivasan, Cambridge University Press, New York, 2001, (ISBN:0521650267).
2. "Smart Materials and Structures", M.V.Gandhi and B.S.Thompson Chapmen & Hall, London, 1992 (ISBN:0412370107)

Reference books:

1. "Foundation of MEMS, by Chang Liu. Pearson Education. (ISBN:9788131764756)

E-Books / Web References

1. https://www.youtube.com/watch?v=5s6-1uREV4A
2. https://www.youtube.com/watch?v=yXHIIowQntk
3. https://www.youtube.com/watch?v=nE1C4ghfvac&list=PLgMDNELGJ1CbufZjqWa8uoSlQWKqVwPN7

MOOCs

1. https://nptel.ac.in/courses/117105082

Scheme of Examination:

Semester End Examination (SEE):

SEE Question paper is to be set for 100 marks and the marks scored will be proportionately reduced to 50. There will be two full questions (with a maximum of four sub questions) from each module carrying 20 marks each. Students are required to answer any five full questions choosing at least **one full question from each module**.

Continuous Internal Evaluation (CIE):

Three Tests are to be conducted for 40 marks each. Average of three tests is taken. CIE is executed by way of one quiz / Alternate Assessment Tools (AATs), and average of three tests. One quiz is to be conducted and evaluated for 10 marks

Some possible AATs:

Assignments/ group activity / any other.

Typical Evaluation pattern for regular courses is shown in Table 2.

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Table 2: Distribution of weightage for CIE & SEE of Regular courses

	Component	Marks	Total Marks
CIE	CIE Test-1	**40**	**50**
	CIE Test-2	**40**	
	CIE Test-2	**40**	
	Quiz /AAT	**10**	
SEE	Semester End Examination	**50**	**50**
Grand Total			**100**

CO/PO Mapping															
CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO73.1	3	2	1			2	2					1			1
CO73.2	3	2	1			2	2					1			1
CO73.3	3	1	1			2	2					1			1
CO73.4	3	2	2			2	2					1			1
CO73.5	3	2	1			2	2					1			1
Average	**3**	**1**	**1**			2	2					1			1

Low - 1: Medium - 2: High - 3

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SEMESTER – VII

Course: CONTROL ENGINEERING

Course Code	**21MED741**	**CIE Marks**	**50**
Hours/Week (L: T: P)	**2 : 2 : 0**	**SEE Marks**	**50**
No. of Credits	**3**	**Examination Hours**	**03**

Prerequisites: Basic Mathematics

Course Objectives: The students will be taught to:

CLO1	Appreciate the importance of control systems in mechanical engineering.
CLO2	Represent the vibration system as electrical sytems.
CLO3	Draw the Root locus, Bode, Polar and Nyquist plot for the given transfer system for further analyses.

Content	No. of Hours/ RBT levels
Module 1 **Introduction:** Concepts of automatic controls, Types of control systems, open and closed loop systems with examples, feedback system. Requirement of an ideal control system. **Mathematical Models:** Models of vibration systems, Transfer function, Numerical on F-I and F-V analogy of vibration systems.	**08 Hours / L1, L2, L3**
Module 2 **Block Diagrams Algebra:** block representation of system elements, reduction of block diagrams, Transfer function of SFG using Mason's formula. **Transient and Steady State Response Analysis:** Different types of inputs, Response of first order and second order to step, ramp and impulse inputs (no derivation), time response specifications and concepts of time constant, numerical problems.	**08 Hours / L1, L2, L3**
Module 3 **Root Locus Plots:** Definition, general rules for constructing root loci, Numerical on plotting the root locus for given transfer function.	**08 Hours / L1, L2, L3**
Module 4 **Frequency Response Analysis:** Relationship between time and frequency response, Bode attenuation plot, Phase and gain margins. **Polar and Nyquist plot:** Simple numerical Phase and gain margins**.**	**08 Hours / L1, L2, L3**
Module 5 **Controllers and System Compensation**: Different types of controllers (P, I, D, PI, PD and PID)**,** Series and feedback compensation.	**08 Hours / L1, L2, L3**

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State Variable Characteristics of Linear Systems: Introduction to state concepts, state equation of linear system. Matrix representation of state equations, controllability and observability, Kalman and Gilbert's test for controllability and observability.	

COURSE OUTCOMES: Upon completion of this course, student will be able to:

CO741.1	Explain different types of control systems and convert the vibrational systems to electrical systems.
CO741.2	Derive the transfer function for the control systems using Block diagram reduction techniques and signal flow graphs.
CO741.3	Deduce the time domain response analysis of 1st and 2nd order control systems.
CO741.4	Construct the root locus, Bode, Polar and Nyquist plot for the given transfer function.
CO741.5	Explain the different types of controllers and system compensation.
CO741.6	Determine the observability and controllability of a system

Textbooks:

1. **Farid G., Kuo B. C**, Automatic Control Systems, McGraw Hill Education, 10th Edition,2018
2. **K. Ogata**, Modern control Engineering, Pearson, 5th Edition, 2010

Reference books:

1. **I J Nagrath, M Gopal,** Control Systems Engineering, New Age International (P) Ltd, 2018.
2. **M.Gopal**, Control systems Principles and Design, 3rd Edition, TMH, 2000.

E-Books / Web References

1. https://www.pdfdrive.com/electrical-and-electronics-engineering-u-bakshi-v-bakshi-d188397301.html
2. https://www.pdfdrive.com/electrical-and-electronics-engineering-u-bakshi-v-bakshi-d188397301.html

MOOCs

1. https://nptel.ac.in/courses/108106098
2. https://onlinecourses.nptel.ac.in/noc20_ee90/preview

Scheme of Examination:

Semester End Examination (SEE):

SEE Question paper is to be set for 100 marks and the marks scored will be proportionately reduced to 50. There will be two full questions (with a maximum of four sub questions) from each module carrying 20 marks each. Students are required to answer any **five full questions** choosing at least **one full question from each module.**

Continuous Internal Evaluation (CIE):

Three Tests are to be conducted for 40 marks each. CIE is executed by way of three tests and a quiz / Alternate Assessment Tools (AATs) for 10 marks.

Some possible AATs:

Assignments/ group activity / any other.

Typical Evaluation pattern for regular courses is shown in Table 2.

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Table 2: Distribution of weightage for CIE & SEE of Regular courses

	Component	Marks	Total Marks
CIE	CIE Test-1	**40**	**50**
	CIE Test-2	**40**	
	CIE Test-3	**40**	
	Quiz /AAT	**10**	
SEE	Semester End Examination	**50**	**50**
Grand Total			**100**

CO/PO Mapping															
CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO741.1	2	2	2	2		1	1					1	2		
CO741.2	2	2	2	2		1	1					1	2		
CO741.3	2	2	2	2		1	1					1	2		
CO741.4	2	2	2	2		1	1					1	2		
CO741.5	2	2	2	2		1	1					1	2		
CO741.6	2	2	2	2		1	1					1	2		
Average	2	2	2	2		1	1					1	2		

Low - 1: Medium - 2: High - 3

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SEMESTER – VII
Course: Refrigeration and Air conditioning

Course Code	**21MED742**	**CIE Marks**	**50**
Hours/Week (L: T: P)	**3 : 0 : 0**	**SEE Marks**	**50**
No. of Credits	**3**	**Examination Hours**	**03**

Prerequisites: Thermodynamics, Heat transfer

Course Objectives: The students will be taught:

CLO1	The basic refrigeration and air-conditioning systems.
CLO2	To analyse simple vapour compression system and vapour absorption systems
CLO3	The usage of psychrometric charts and estimation of cooling loads.
CLO4	The applications of refrigeration and air-conditioning.

Content	No. of Hours/ RBT levels
Module 1 **Vapour Compression Refrigeration System** Review of thermodynamic principles of refrigeration, Different types of refrigerants, Boot stage systems; Performance of simple vapour compression system, single and multi-load system, COP	**8 Hours / L1, L2, L3**
Module 2 **Absorption Refrigeration System** Basic absorption system, COP, Refrigerator, Advantage and limitation over vapour compression system, Binary mixtures, Temperature concentration diagram, Aqua ammonia system and energy balance	**8 Hours / L1, L2, L3**
Module 3 **Refrigeration Equipment and Control** Compressor-principle of operation, specifications, condenser – types and specification, selection, Evaporator, Expansion devices, high and low pressure sensors, defrosting, types of defrosting devices, capacity control devices.	**8 Hours / L1, L2, L3**
Module 4 **Psychrometric Charts and Cooling Loads** Psychometric processes, Use of Charts, Summer and winter air-conditioning; Comfort air-conditioning, sensible heat loads, latent heat loads, sensible heat factors, cooling coils, de-humidifiers	**8 Hours / L1, L2, L3**
Module 5 **Types of Air-Conditioning Systems** Central, unitary, split air-conditioner, layout of sub-systems, selection of air-conditioner for a room; **Applications of Refrigeration and Air-Conditioning** Principles of ice production, food preservation, transport air conditioning and milk chilling plant	**8 Hours / L1, L2, L3**

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COURSE OUTCOMES: Upon completion of this course, student will be able to:

CO742.1	Analyze the principles of vapor compression refrigeration systems by applying advanced principles of refrigeration.
CO742.2	Evaluate and innovate the performance of vapor absorption refrigeration systems to enhance efficiency and application in various contexts.
CO742.3	Implement advanced control strategies for various components of refrigeration equipment to improve system reliability and performance.
CO742.4	Apply advanced psychrometric analysis techniques to optimize air conditioning processes for improved indoor air quality and energy efficiency.
CO742.5	Evaluate various air conditioning systems and their applications to meet specific environmental and operational requirements effectively.

Textbooks:

1. Refrigeration and Air-conditioning, **Arora. C.P**., 3rd Edition, 2009 , Tata McGraw Hill,
2. ISBN: 978007008390-5
3. A Text Book of Refrigeration and Air-Conditioning, **Rajput. R.K.**, 2009 , S.K. Katraia, New Delhi, ISBN: 098869007-1

Reference books:

1. Refrigeration and Air conditioning, **Stoecker**. W.F., Jones. J.W, 2nd Edition, 1982 , Tata McGraw Hill , ISBN: 0070616191
2. Principles of Refrigeration, **Dossat. R.J. Horan. T.J**., 5th Edition, 2006 , Prentice Hall, ISBN: 013027270
3. "Principles of Air Conditioning", V Paul Lang, Delmar Cengage Learning, 1995. "Refrigeration & Air Conditioning Data Hand book" , Manohar Prasad , New Age International, 2nd Edition. 2013.

E-Books / Web References

1. http://nptel.ac.in/courses/112105128/
2. http://nptel.ac.in/courses/112105128/45
3. https://freevideolectures.com/course/2372/refrigeration-and-air-conditioning

MOOCs

https://onlinecourses.nptel.ac.in/noc19_me58/preview

Scheme of Examination:

Semester End Examination (SEE):

SEE Question paper is to be set for 100 marks and the marks scored will be proportionately reduced to 50. There will be two full questions (with a maximum of four sub questions) from each module carrying 20 marks each. Students are required to answer any **five full questions** choosing at least **one full question from each module.**

Continuous Internal Evaluation (CIE):

Three Tests are to be conducted for 40 marks each. The average of the three tests are taken for computation of CIE. The assignment component would be for 10 marks. CIE is executed by way of quizzes / Alternate Assessment Tools (AATs), and three tests.

Some possible methods of assessment for assignments: Assignments / Oral presentations / Group activity/Projects.

Typical Evaluation pattern for regular courses is shown in Table 2.

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Table 2: Distribution of weightage for CIE & SEE of Regular courses

	Component	Marks	Total Marks
CIE	CIE Test-1	**40**	**50**
	CIE Test-2	**40**	
	CIE Test-3	**40**	
	Assignment/Quiz /AAT	**10**	
SEE	Semester End Examination	**100**	**50**
Grand Total			**100**

CO/PO Mapping															
CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO742.1	3	2	1	1	2	1	1				1	1		1	
CO742.2	3	2	1	1	2	1	1				1	1		1	
CO742.3	3	2	1	2	1	1	1				1	1		1	
CO742.4	3	2	1	2	1	1	1				1	1		1	
CO742.5	3	2	1	1	1	1	1				1	1		1	
Average	3	2	1	2	2	1	1				1	1		1	

Low - 1: Medium - 2: High - 3

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SEMESTER – VII

Course: Composite Material Technology

Course Code	21MED743	CIE Marks	50
Hours/Week (L: T: P)	3 : 0 : 0	SEE Marks	50
No. of Credits	3	Examination Hours	03

Prerequisites: Material science & Metallurgy

Course Objectives: The students are enabled to:

CLO1	Understand the behaviour of constituents in the composite materials and its applications
CLO2	Explain the different types of reinforcement and matrices used in composites
CLO3	Understand the various manufacturing processes of Composite materials
CLO4	Gain the knowledge in the Processing & structure of Multi filamentary superconducting composites
CLO5	Know the use of SEM, XRD, TEM, and AFM

Content	No. of Hours/ RBT levels
Module 1 **Introduction to Composite Materials:** Definition, classification & need of composite materials. Advantages, limitations, and applications. **Constituent of composite materials:** Reinforcements, Matrix. **Reinforcements:** Introduction, Glass Fibers, Boron Fibers, Carbon Fibers, Organic Fibers, Ceramic Fibers, and Whiskers, **Matrix Materials:** Polymers, Metals and Ceramic Matrix Materials.	**08 Hours / L1, L2, L3**
Module 2 **Fiber Reinforced Plastic Processing:** fabricating process, open and closed mould processes, hand layup techniques; structural laminate bag molding, production procedures for bag molding; filament winding, pultrusion, injection molding, blow molding.	**08 Hours / L1, L2, L3**
Module 3 **Metal Matrix Composites:** Reinforcement materials, types, characteristics, and selection of base metals. Need for production MMC's and its application. **Fabrication Process for MMC's:** Powder metallurgy technique, liquid metallurgy technique and secondary processing, special fabrication techniques.	**08 Hours / L1, L2, L3**
Module 4 **Ceramic Matrix Composites (CMC): Processing of CMC's;** Cold Pressing & Sintering, Hot Pressing, Reaction Bonding Processes, Infiltration, In Situ Chemical Reaction Technique, applications of CMC's.	**08 Hours / L1, L2, L3**

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Carbon Fiber/Carbon Matrix Composites: Processing of Carbon/Carbon Composites, Oxidation protection of Carbon/Carbon Composites, Properties of Carbon/Carbon Composites, and application of Carbon/Carbon Composites.	
Module 5 **Multifilamentary Superconducting Composites:** The Problem of Flux Pinning, Types of Super Conductor, Processing & structure of Multi filamentary superconducting composites. Applications of multifilamentary superconducting composites. Characterization of Composites-**XRD, SEM, TEM, and AFM**	**08 Hours / L1, L2, L3**

COURSE OUTCOMES: Upon completion of this course, student will be able to:

CO743.1	Evaluate the fundamental constituents of diverse composite materials to make informed decisions on material selection for specific applications.
CO743.2	Apply the various production processes for Fiber Reinforced Plastic composites to optimize manufacturing efficiency and product performance.
CO743.3	Justify the selection of suitable fabrication processes for Metal Matrix Composites, considering application-specific requirements and performance criteria.
CO743.4	Evaluate advanced processing techniques for Ceramic Matrix Composites and Carbon-Carbon Composites to enhance their structural integrity and functional properties.
CO743.5	Apply advanced methods for processing and characterizing Multi-Filamentary Superconducting Composites to improve their performance and evaluate their structural and functional properties effectively.

Textbooks:

1. Composite Material Science and Engineering, **Krishan K. Chawla**, Springer, Third Edition, First Indian
2. Fibre-Reinforced Composites, Materials, Manufacturing, and Design, P.K. Mallick, Third Edition, CRC.Press, Taylor & Francis Group.

Reference books:

1. Autar K. Kaw, Mechanics of Composite materials, CRC Taylor & Francis, 2nd Ed, 2005.
2. Robert M. Jones, Mechanics of Composite Materials, Taylor & Francis, 1999.
3. Madhijit Mukhopadhay, Mechanics of Composite Materials & Structures, Universities Press,2004.

E-Books / Web References

1. E - Books: https://www.pdfdrive.com/mechanics-of-composite-materials-second-edition-d39890371.html
2. https://vdoc.pub/download/composite-materials-science-and-engineering-7fs1b0mgdis0
3. https://www.pdfdrive.com/fiber-reinforced-composites-materials-manufacturing-and-design-third-edition-d164990316.html

MOOCs

1. NPTEL Course: "Composite materials" https://nptel.ac.in/courses/112104168
2. NPTEL Course: https://onlinecourses.nptel.ac.in/noc20_me95/preview

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3. NPTEL Course: "Polymer composites"https://www.digimat.in/nptel/courses/video/112107221/L40.html
4. NPTEL Course: "Carbon composites" https://nptel.ac.in/courses/113105081
5. NPTEL Course: "Carbon composites " https://nptel.ac.in/courses/112107086

Scheme of Examination:

Semester End Examination (SEE):

SEE Question paper is to be set for 100 marks and the marks scored will be proportionately reduced to 50. There will be two full questions (with a maximum of four sub questions) from each module carrying 20 marks each. Students are required to answer any **five full questions** choosing at least **one full question from each module.**

Continuous Internal Evaluation (CIE):

Three Tests are to be conducted for 40 marks each. Average of three tests is taken. CIE is executed by way of one quiz / Alternate Assessment Tools (AATs), and average of three tests. One quiz is conducted and evaluated for 10 marks.

Some possible AATs:

Assignments/ group activity / any other.

Typical Evaluation pattern for regular courses is shown in Table 2.

Table 2: Distribution of weightage for CIE & SEE of Regular courses

	Component	Marks	Total Marks
CIE	CIE Test-1	**40**	**50**
	CIE Test-2	**40**	
	CIE Test-3	**40**	
	Quiz 1/AAT	**10**	
SEE	Semester End Examination	**50**	**50**
Grand Total			**100**

CO/PO Mapping															
CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO743.1	3	2	1			2	2					1			2
CO743.2	3	2	1			2	2					1			2
CO743.3	3	2	1			2	2					1			2
CO743.4	3	2	1			2	2					1			2
CO743.5	3	2	1			2	2					1			2
Average	3	1	1			2	2					1			2

Low - 1: Medium - 2: High - 3

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SEMESTER – VII
Course: TOTAL QUALITY MANAGEMENT

Course Code	**21MED744**	**CIE Marks**	**50**
Hours/Week (L: T: P)	**3 : 0 : 0**	**SEE Marks**	**50**
No. of Credits	**3**	**Examination Hours**	**03**

Prerequisites: Management & Entrepreneurship

Course Objectives: The students are taught to:

CLO1	Understand the various approaches to TQM and Quality management system.
CLO2	Explain The characteristics of quality leader and his role.
CLO3	Know the Develop feedback and suggestion systems for quality management.
CLO4	The knowledge in Tools and Techniques of quality management

Content	No. of Hours/ RBT levels
Module 1 **Principles and Practice:** Definition, basic approach, gurus of TQM, TQM Framework, awareness, defining quality, historical review, obstacles, benefits of TQM. **Quality Management Systems**: Introduction, benefits of ISO registration, ISO 9000 series of standards, ISO 9001 requirements.	**08 Hours / L2**
Module 2 **Leadership:** Definition, characteristics of quality leaders, leadership concept, characteristics of effective people, ethics, the Deming philosophy, role of TQM leaders, implementation, core values, concepts and framework, strategic planning communication, decision making,	**08 Hours / L2**
Module 3 **Customer Satisfaction and Customer Involvement**: Customer Satisfaction: customer and customer perception of quality, feedback, using customer complaints, service quality, translating needs into requirements, customer retention, case studies. **Employee Involvement** – Motivation, employee surveys, empowerment, teams, suggestion system, recognition and reward, gain sharing, performance appraisal, unions and employee involvement, case studies.	**08 Hours / L2**
Module 4 **Continuous Process Improvement:** process, the Juran trilogy, improvement strategies, types of problems, the PDSA Cycle, problem-solving methods, Kaizen, reengineering, six sigma, **Statistical Process Control:** Pareto diagram, process flow diagram, cause and effect diagram, check sheets, histograms, statistical fundamentals, Control charts, state	**08 Hours / L2**

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of control, out of control process, control charts for variables, control charts for attributes, scatter diagrams, case studies.	
Module 5 **Tools and Techniques:** Benching marking, information technology, quality management systems, environmental management system, and quality function deployment, quality by design, failure mode and effect analysis, product liability, total productive maintenance	**08 Hours / L2**

COURSE OUTCOMES: Upon completion of this course, student will be able to:

CO744.1	Evaluate various approaches to Total Quality Management (TQM) and analyze the standards and requirements of ISO 9000 and ISO 9001, including the benefits of implementing the ISO 9000 series.
CO744.2	Assess the characteristics of quality leaders, effective individuals, and ethical considerations.
CO744.3	Examine the importance of customer satisfaction and employee involvement through detailed case studies.
CO744.4	Apply statistical tools for the continuous improvement of quality systems, and evaluate their effectiveness in real-world scenarios.
CO744.5	Implement tools and techniques for effective TQM, and identify areas for quality improvement using Quality Function Deployment (QFD) and Failure Mode and Effects Analysis (FMEA).

Textbooks:

1. Dale H. Besterfield et al, Total Quality Management, Third edition, Pearson Education. (First Indian Reprints 2004).
2. Shridhara Bhat K, Total Quality Management – Text and Cases, Himalaya Publishing House, First Edition 2002.

Reference books:

1. M. Zairi, Total Quality Management for Engineers, Woodhead Publishing.
2. A New American TQM, four revolutions in management, ShojiShiba, Alan Graham, David Walden, Productivity press, Oregon.
3. 100 Methods for Total Quality Management: Gopal K. Kanji and Mike Asher, ISBN: 0803977476, Publisher: Sage Publications, Inc.;Edition – 1

E-Books / Web References

1. **Gurus of TQM**
   - https://www.focusstandards.org/quality-gurus-key-contributions/
2. **TQM Framework**
   - https://www.emeraldinsight.com/doi/abs/10.1108/eb060192
3. **Principles of TQM:**
   - https://study.com/academy/lesson/five-principles-of-total-quality-management-tqm.html
4. **Characteristics of quality leaders**
   - https://www.mechlectures.com/leadership-characteristics-quality-leaders/
   - https://www.briantracy.com/blog/leadership-success/the-seven-leadership-qualities-of-great-leaders-strategic-planning/
5. **Customer Satisfaction and Customer Involvement**
   - https://www.emeraldinsight.com/doi/abs/10.1108/17566691311316248

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- https://study.com/academy/lesson/consumer-involvement-in-the-decision-making-process.html

6. **Statistical Process Control**
   - http://asq.org/learn-about-quality/seven-basic-quality-tools/overview/overview.html
   - https://www.whatissixsigma.net/7-qc-tools/
7. **Design for Six Sigma**
   - https://quality-one.com/six-sigma/

MOOCs

1. NPTEL Course: "Total Quality Management" https://archive.nptel.ac.in/courses/110/104/110104080/
2. NPTEL Course: "Total Quality Management" https://archive.nptel.ac.in/noc/courses/noc20/SEM1/noc20-mg34/

Scheme of Examination:

Semester End Examination (SEE):

SEE Question paper is to be set for 100 marks and the marks scored will be proportionately reduced to 50. There will be two full questions (with a maximum of four sub questions) from each module carrying 20 marks each. Students are required to answer any **five full questions** choosing at least **one full question from each module.**

Continuous Internal Evaluation (CIE):

Three Tests are to be conducted for 40 marks each. Average of three tests is taken. CIE is executed by way of one quiz / Alternate Assessment Tools (AATs), and average of three tests. One quiz is conducted and evaluated for 10 marks.

Some possible AATs:

Assignments/ group activity / any other.

Typical Evaluation pattern for regular courses is shown in Table 2.

Table 2: Distribution of weightage for CIE & SEE of Regular courses

	Component	Marks	Total Marks
CIE	CIE Test-1	**40**	**50**
	CIE Test-2	**40**	
	CIE Test-3	**40**	
	Quiz 1/AAT	**10**	
SEE	Semester End Examination	**50**	**50**
Grand Total			**100**

CO/PO Mapping															
CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO744.1	2	1	1			1	1	1		1	3	2			2
CO744.2	2	1	1			1	1	1		1	3	2			2
CO744.3	2	1	1			1	1	1		1	3	2			2
CO744.4	2	1	1			1	1	1		1	3	2			2
CO744.5	2	1	1			1	1	1		1	3	2			2
Average	2	1	1			1	1	1		1	3	2			2

Low - 1: Medium - 2: High - 3

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SEMESTER – VII

OPEN ELECTIVE- 2

Course: Additive Manufacturing

Course Code	**21MED751**	**CIE Marks**	**50**
Hours/Week (L: T: P)	**3 : 0 : 0**	**SEE Marks**	**50**
No. of Credits	**3**	**Examination Hours**	**03**

Prerequisites: Elements of Mechanical Engineering

Course Objectives: The students will be taught

CLO1	The classification and steps involved in Additive Manufacturing
CLO2	The various techniques and applications of additive manufacturing.
CLO3	The various types of raw materials used in additive manufacturing process.
CLO4	The Process parameters and the common faults confronted in additive manufacturing equipment and process design.
CLO5	The post processing techniques involved in additive manufacturing.

Content	No. of Hours/ RBT levels
Module 1 Introduction, Process, Classification, Advantages, Additive V/s Conventional Manufacturing processes, Applications. CAD for Additive Manufacturing: CAD Data formats, Data translation, Data loss, STL format.	**8 Hours / L1, L2, L3**
Module 2 Additive Manufacturing Techniques: Fusion Deposition Modelling: Process, Process parameter, Process Selection for various applications. Introduction to Stereo-Lithography, LOM, SLS, SLM, Binder Jet technology. Additive Manufacturing Application Domains: Aerospace, Electronics, Health Care, Defence, Automotive, Construction, Food Processing, Machine Tools	**8 Hours / L1, L2, L3**
Module 3 Materials: Polymers, Metals, Non-Metals, Ceramics, Various forms of raw material-Liquid, Solid, Wire, Powder; Powder Preparation and their desired properties, Polymers and their properties. Support Materials	**8 Hours / L1, L2, L3**
Module 4 Additive Manufacturing Equipment: Process Equipment- Design and process parameters, Governing Bonding Mechanism, Common faults and troubleshooting, Process Design	**8 Hours / L1, L2, L3**
Module 5 Post Processing: Requirement and Techniques, Product Quality: Inspection and testing, Defects and their causes	**8 Hours / L1, L2, L3**

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LIST OF PRACTICALS

1. 3D Modelling of a single component.
2. Assembly of CAD modelled Components
3. Exercise on CAD Data Exchange.
4. Generation of .stl files.
5. Identification of a product for Additive Manufacturing and its AM process plan.
6. Printing of identified product on an available AM machine.
7. Post processing of additively manufactured product.
8. Inspection and defect analysis of the additively manufactured product.
9. Comparison of Additively manufactured product with conventional manufactured counterpart

COURSE OUTCOMES: Upon completion of this course, student will be able to:

CO751.1	Synthesize complex CAD models for 3D printing, effectively manage CAD data interchange, and generate optimized .stl files for advanced additive manufacturing applications.
CO751.2	Integrate the generic processes and working principles of additive manufacturing to innovate and enhance production methodologies.
CO751.3	Justify the selection of specific materials for given applications, optimizing their properties and performance in additive manufacturing.
CO751.4	Troubleshoot complex issues in 3D printing hardware, ensuring optimal operation and maintenance of advanced additive manufacturing systems.
CO751.5	Implement advanced post-processing techniques and perform thorough inspections to identify and rectify defects in 3D printed parts, ensuring high-quality outputs.

Textbooks:

1. Ian Gibson, David W. Rosen and Brent Stucker, Additive manufacturing technologies: rapid prototyping to direct digital manufacturing, Springer.
2. J.D. Majumdar and I. Manna, Laser-assisted fabrication of materials, Springer Series in Material Science, 2013.of Materials, 3rd Edition, CBS Publishers.

Reference books:

1. Andreas Gebhardt, Understanding additive manufacturing: rapid prototyping, rapid tooling, rapid manufacturing, Hanser Publishers.
2. C.K. Chua, K.F. Leong and C.S. Lim, Rapid prototyping: Principles and applications, 3rd Edition, World Scientific.
3. Additive Manufacturing: Principles, Technologies and Applications, C.P Paul, A.N Junoop, McGrawHill, 2021.

E-Books / Web References

- https://www.nist.gov/additive-manufacturing
- https://www.metal-am.com/
- http://additivemanufacturing.com/basics/
- https://www.3dprintingindustry.com/

MOOCs

- NPTEL Course: ''Fundamentals of Additive Manufacturing Technologies'' https://nptel.ac.in/courses/112103306
- NPTEL Course: "Rapid Manufacturing" https://onlinecourses.nptel.ac.in/noc20_me50/preview

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- MOOC Course: “Principle and development of additive manufacturing technologies”, (https://onlinecourses.nptel.ac.in/noc19_me47/preview)

Scheme of Examination:

Semester End Examination (SEE):

SEE Question paper is to be set for 100 marks and the marks scored will be proportionately reduced to 50. There will be two full questions (with a maximum of four sub questions) from each module carrying 20 marks each. Students are required to answer any **five full questions** choosing at least **one full questionfrom each module.**

Continuous Internal Evaluation (CIE):

Three Tests are to be conducted for 40 marks each. The average of the three tests are taken for computation of CIE. The assignment component would be for 10 marks. CIE is executed by way of quizzes / Alternate Assessment Tools (AATs), and three tests.

Some possible methods of assessment for assignments: Assignments / Oral presentations / Group activity/Projects.

Typical Evaluation pattern for regular courses is shown in Table 2.

Table 2: Distribution of weightage for CIE & SEE of Regular courses

	Component	Marks	Total Marks
CIE	CIE Test-1	**40**	**50**
	CIE Test-2	**40**	
	CIE Test-3	**40**	
	Assignment/Quiz /AAT	**10**	
SEE	Semester End Examination	**100**	**50**
Grand Total			**100**

CO/PO Mapping															
CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO751.1	3	2	1	1	3	2	-	-	-	-	-	1			3
CO751.2	3	2	1	1	-	2	-	-	-	-	-	1			3
CO751.3	3	1	1	1	-	2	3	-	-	-	-	1			3
CO751.4	3	2	1	1	-	2	-	-	-	-	-	1			3
CO751.5	3	1	1	1	-	2	-	-	-	-	-	1			3
Average	**3**	**2**	**1**	**1**	**3**	**2**	**3**	**-**	**-**	**-**	**-**	**1**			**3**

Low - 1: Medium - 2: High - 3

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SEMESTER – VII

OPEN ELECTIVE- 2

Course: Supply Chain Management

Course Code	**21MED752**	**CIE Marks**	**50**
Hours/Week (L: T: P)	**3 : 0 : 0**	**SEE Marks**	**50**
No. of Credits	**3**	**Examination Hours**	**03**

Prerequisites: Management and Entrepreneurship

Course Objectives: This course will enable the students to:

CLO1	Understand the stages, decision phases and process views in supply chain management
CLO2	Identify the major drivers of supply chain performance.
CLO3	Describe inventory management, transportation and the key factors considered in designing a distribution network.
CLO4	Develop a frame work for making network design decisions and coordination in supply chain.
CLO5	Discuss the importance of supply chain restructuring and the future of IT in supply chain management.

Content	No. of Hours/ RBT levels
Module 1 **Introduction to Supply Chain:** Fundamentals of Supply Chain, Stages, Objectives, Importance, Decision Phases and Process Views in Supply chain. Competitive and Supply Chain strategies, Achieving strategic fit, Supply Chain performance measures. **Case Studies:** Example- Toyota: A global Auto Manufacturer, Amazon.com: An E-Business.	**8 Hours / L1, L2, L3**
Module 2 **Supply Chain Drivers and Metrics:** Drivers of Supply Chain Performance, Framework for structuring Drivers, Facilities, Inventory, Transportation, Information, Sourcing and Pricing. **Case Studies:** Example- Seven Eleven Japan Company, E- Sourcing at Marico.	**8 Hours / L1, L2, L3**
Module 3 **Material Flow in Supply Chains:** Inventory Management- Types of Inventory, Inventory-related Costs. Transportation- Drivers of Transportation Decisions Comparison of modes of transportation on Supply Chain performance measures. **Designing Distribution Networks and Application to E-Business**: Role of distribution, factors influencing distribution network design, design options for a distribution network, E-Business and the distribution network.	**8 Hours / L1, L2, L3**
Module 4 **Network Design in the Supply Chain:** Role of network design in the supply chain, factors influencing network design decisions, framework for network design decisions.	**8 Hours / L1, L2, L3**

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Coordination in a supply chain: Lack of supply chain coordination and Bullwhip Effect, Effect on performance due to lack of coordination, obstacles to coordination in a supply chain.	
Module 5 **Supply Chain Restructuring:** Supply Chain Mapping, Supply Chain process restructuring, Postponement Case Studies: Hewlett-Packard: postponement of product differentiation, Benetton: postponement by re sequencing of processes. **Information Technology in supply chain:** Role of IT in a supply chain, Customer relationship management, Internal supply chain management, Supplier relationship management, Future of IT in supply chain and Risk management in IT.	**8 Hours / L1, L2, L3**

COURSE OUTCOMES: Upon completion of this course, student will be able to:

CO752.1	Analyze the fundamentals and scope of supply chain management and evaluate their significance in business operations.
CO752.2	Assess the roles and performance of various drivers in supply chain management and determine their impact on overall efficiency.
CO752.3	Design material flow, inventory management, and transportation systems for effective distribution networks in E-business, and optimize their performance.
CO752.4	Evaluate the role of network design and coordination in supply chain management and formulate strategies for enhancing integration and performance.
CO752.5	Assess the importance of supply chain restructuring and analyze the impact of information technology on supply chain operations and efficiency.

Textbooks:

1. **Sunil Chopra and Peter Meindl**, Supply Chain Management, 3rdEdition, Pearson Education 2007.
2. **Janat Shah**, Supply Chain Management, Text and Cases, Pearson Education 2009.

Reference books:

1. Supply Chain Management Theories & Practices, R. P. Mohanty, S. G. Deshmukh, Dreamtech Press, 19-A, Anari Road, Daryaganj, New Delhi.
2. Total Supply Chain Management by Ron Basu, J. Nevan Wright.
3. Supply Chain Management, Chopra, Pearson
4. David Simchi-Levi, Philp Kamintry and Edith Simchy Levy, Designing and Managing the Supply Chain - Concepts Strategies and Case Studies, 2nd Edition, Tata-McGraw Hill.

E-Books / Web References

1. **E - Books:** "Strength of Materials", (http://freeengineeringbooks.com/Civil/Strength-of-Material-Books.php)
2. https://www.pdfdrive.com/global-supply-chain-management-and-international-logistics-d162358148.html
3. https://www.pdfdrive.com/innovative-methods-in-logistics-and-supply-chain-management-d34408414.html

NPTEL

1. NPTEL Course: "Global Supply Chain Management" https://nptel.ac.in/courses/110108056

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2. NPTEL Course: “Operations and Supply Chain Management” https://nptel.ac.in/courses/110106045
3. NPTEL Course: “Modelling and Analytics for Supply Chain Management’’ https://nptel.ac.in/courses/110105141

Scheme of Examination:

Semester End Examination (SEE):

SEE Question paper is to be set for 100 marks and the marks scored will be proportionately reduced to 50. There will be two full questions (with a maximum of four sub questions) from each modulecarrying 20 marks each. Students are required to answer any **five full questions** choosing at least **one full questionfrom each module.**

Continuous Internal Evaluation (CIE):

Three Tests are to be conducted for 40 marks each. Average of three tests is taken. CIE is executed by way of one quiz / Alternate Assessment Tools (AATs), and average of three tests. One quiz is conducted and evaluated for 10 marks.

Some possible AATs:

Assignments/ group activity / any other.

Typical Evaluation pattern for regular courses is shown in Table 2.

Table 2: Distribution of weightage for CIE & SEE of Regular courses

	Component	Marks	Total Marks
CIE	CIE Test-1	**40**	**50**
	CIE Test-2	**40**	
	CIE Test-3	**40**	
	Quiz 2/AAT	**10**	
SEE	Semester End Examination	**50**	**50**
Grand Total			**100**

CO/PO Mapping															
CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO752.1	2	2	1			3	3	1				2			
CO752.2	2	2	1			3	3	1				2			
CO752.3	2	2	1			3	3	1				2			
CO752.4	2	2	1			3	3	1				2			
CO752.5	2	2	1			3	3	1				2			
Average	**2**	**2**	**1**			**3**	**3**	**1**				**2**			

Low - 1: Medium - 2: High - 3

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SEMESTER – VII

Course: Project Phase - I

Course Code	21MED76	CIE Marks	100
Hours/Week (L: T: P)	0 : 0 : 2	SEE Marks	-
No. of Credits	2	Examination Hours	

Project work Phase-I: Based on the ability/abilities of the student/s and recommendations of the mentor, a single discipline or a multidisciplinary project can be assigned to an individual student or to a group having not more than 4 students. In extraordinary cases, like the funded projects requiring students from different disciplines, the project student strength can be 5 or 6.

1. **Single discipline**: The CIE marks shall be awarded by a committee consisting of the Head of the concerned Department and two senior faculty members of the Department, one of whom shall be the Guide. The CIE marks awarded for the project work phase -1, shall be based on the evaluation of the project work phase -1 Report (covering Literature Survey, Problem identification, Objectives and Methodology), project presentation skill and question and answer session in the ratio 50:25:25.The marks awarded for the Project report shall be the same for all the batch mates.

2. **Interdisciplinary**: Continuous Internal Evaluation shall be group wise at the college level with the participation of all guides of the college. Participation of external guide/s, if any, is desirable. The CIE marks awarded for the project work phase -1, shall be based on the evaluation of project work phase -1 Report (covering Literature Survey, Problem identification, Objectives and Methodology), project presentation skill and question and answer session in the ratio 50:25:25.The marks awarded for the project report shall be the same for all the batch mates as per rubrics covering all Program Outcomes.

Typical Evaluation pattern for regular courses is shown in Table 2.

Table 2: Distribution of weightage for CIE & SEE of Regular courses

	Component	Marks	Total Marks
CIE	Preliminary review	-	100
	Review-1	100	
Grand Total			100

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SEMESTER – VII

Course: Design and Simulation Lab

Course Code	20MEDL77	CIE Marks	50
Hours/Week (L: T: P)	0 : 0 : 2	SEE Marks	50
No. of Credits	1	Examination Hours	03

Prerequisites: Strength of materials, Mechanical Vibrations, Dynamics of machines

Course Objectives: The students will be taught to:

CLO1	Demonstrate the concepts discussed in Mechanical Vibrations & Dynamics of Machines courses.
CLO2	Visualize and understand the development of stresses in structural members and experimental determination of stresses in members utilizing the optical method of reflected photoelasticity.

Content	No. of Hours/ RBT levels
Part-A 1. Determination of natural frequency of a spring mass system. 2. Determination of natural frequency logarithmic decrement, damping ratio and damping Co-efficient in a single degree of freedom vibrating systems (longitudinal and torsional). 3. Determination of critical speed of rotating shaft. 4. Balancing of rotating masses.	**14** **L1, L2, L3**
Part-B 5. Determination of fringe constant of Photo-elastic material using Circular disk subjected diametric compression, Pure bending specimen (four-point bending) 6. Determination of principle stresses and strain in a member subjected to combined loading using strain rosettes. 7. Determination of equilibrium speed, sensitiveness, power, and effort of Porter/Watt Governor. 8. Determination of pressure distribution in Journal bearing 9. Experiments on Gyroscope (Demonstration only)	**14** **L1, L2, L3**

COURSE OUTCOMES: Upon completion of this course, student will be able to:

CO1	Understand the working principles of machine elements such as Governors, Gyroscopes etc.
CO2	Identify forces and couples in rotating mechanical system components.
CO3	Identify vibrations in machine elements and design appropriate damping methods and to determine the critical speed of a rotating shaft.
CO4	Measure strain in various machine elements using strain gauges.
CO5	Determine the minimum film thickness, load carrying capacity, frictional torque and pressure distribution of journal bearing
CO6	Determine strain induced in a structural member using the principle of photo-elasticity.

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Reference books:

1. "Shigley"s Mechanical Engineering Design", Richards G. Budynas and J. Keith Nisbett, McGraw-Hill Education, 10th Edition, 2015.
2. "Design of Machine Elements", V.B. Bhandari, TMH publishing company Ltd. New Delhi, 2nd Edition 2007.
3. "Theory of Machines", Sadhu Singh, Pearson Education, 2nd Edition, 2007.
4. "Mechanical Vibrations", G.K. Grover, Nem Chandand Bros, 6th Edition, 1996.

E-Books / Web References

1. https://www.youtube.com/watch?v=Ujtv5NY4Sq8&list=PL21BB25670CDC2AEB

Vibration simulation videos

1. https://www.youtube.com/watch?v=qcHjDLCJxfI
2. https://www.youtube.com/watch?v=Vj1xmze3GlE
3. https://www.youtube.com/watch?v=-BPbfRX4j0A

Scheme of Examination:

Semester End Examination (SEE):

SEE Question paper is to be set for 100 marks and the marks scored will be reduced to 50.

Continuous Internal Evaluation (CIE): Weekly Performance – Lab participation and report will be evaluated for 30 Marks and one Internal assessment is conducted at the end of semester for 20 Marks.

Typical Evaluation pattern for regular courses is shown in Table 2.

Table 2: Distribution of weightage for CIE & SEE of Regular courses

	Component	Marks	Total Marks
CIE	Weekly Performance – Lab participation and report	**30**	**50**
	One IA at the end of semester	**20**	
SEE	Semester End Examination	**50**	**50**
Grand Total			**100**

CO/PO Mapping															
CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
21MEDL77.1	2	1	1	1		1	1	2	3	3		1	2		
21MEDL77.2	2	1	1	1		1	1	2	3	3		1	2		
21MEDL77.3	2	1	1	1		1	1	2	3	3		1	2		
21MEDL77.4	2	1	1	1		1	1	2	3	3		1	2		
21MEDL77.5	2	1	1	1		1	1	2	3	3		1	2		
21MEDL77.6	2	1	1	1		1	1	2	3	3		1	2		
Average	**2**	**1**	**1**	**1**		**1**	**1**	**2**	**3**	**3**		**1**	**2**		

Low - 1: Medium - 2: High - 3

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VIII SEMESTER

SYLLABUS

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SEMESTER –VIII
Course: RENEWABLE ENERGY TECHNOLOGIES

Course Code	**21MED811**	**CIE Marks**	**50**
Hours/Week (L: T: P)	**3 : 0 : 0**	**SEE Marks**	**50**
No. of Credits	**3**	**Examination Hours**	**03**

Prerequisites: NiL

Course Objectives: To provide an insight to**,**

CLO1	To introduce students to various energy sources, with a focus on solar radiation and its measurement, and to understand the energy scenario in India and globally.
CLO2	To provide students with an in-depth understanding of solar radiation geometry and its application in solar thermal and photovoltaic systems, focusing on practical aspects and system components.
CLO3	To introduce students to the principles and applications of wind and biomass energy, covering the characteristics, design, and challenges associated with these renewable energy sources.
CLO4	To provide students with a comprehensive understanding of hydroelectric, tidal, and wave energy systems, including their mechanics, design, advantages, and limitations.
CLO5	To explore the principles and applications of ocean thermal energy conversion (OTEC) and geothermal energy.

Content	**No. of Hours/ RBT levels**
Module 1 **Introduction:** Energy sources (including fossil fuels and nuclear energy), India's production and reserves of commercial energy sources, need for nonconventional energy sources, energy alternatives, Indian and global energy scenario. **Solar Radiation & Measurement:** Extra-Terrestrial radiation, spectral distribution of extra-terrestrial radiation, solar constant, solar radiation at the earth's surface, beam, diffuse and global radiation, solar radiation data. Pyrometer, shading ring Pyrheliometer, sunshine recorder, schematic diagrams, and principle of working, actinometer and bolometer.	**08 Hrs. / L3**
Module 2 **Solar Radiation Geometry:** Flux on a plane surface, latitude, declination angle, surface azimuth angle, hour angle, zenith angle, solar altitude angle, expressions for the angle between the incident beam and the normal to a plane surface (No derivation) local apparent time, apparent motion of sun, day length, numerical problems. **Solar Thermal Systems:** Flat plate collector, Evacuated Tubular Collector, Solar air collector, Solar concentrator, Solar distillation, Solar cooker, Thermal energy storage systems, Solar Pond, Solar Chimney (Tower). **Solar Photovoltaic Systems:** Introduction, Solar cell Fundamentals, Characteristics and classification, Solar cell: Module, panel and array construction.	**08 Hrs. / L3**

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Module 3 **Wind Energy:** Properties of wind, availability of wind energy in India, wind velocity and power from wind; major problems associated with wind power, wind machines; Types of wind machines and their characteristics, horizontal and vertical axis windmills, elementary design principles; coefficient of performance of a windmill rotor, design aspects, numerical examples. **Energy from Biomass:** Energy plantation, biogas production from organic wastes by anaerobic fermentation, description of bio-gas plants, transportation of biogas, problems associated with bio-gas production, application of biogas, application of biogas in engines, cogeneration plant, advantages & disadvantages.	**08 Hrs. / L3**
Module 4 **Hydroelectric plants:** Advantages & disadvantages of waterpower, Hydrographs and flow duration curves - numerical, Storage and pondage, General layout of hydel power plants- components such as Penstock, surge tanks, spill way and draft tube and their applications, pumped storage plants, Detailed classification of hydroelectric plants. **Tidal Power:** Tides and waves as energy suppliers and their mechanics, fundamental characteristics of tidal power, harnessing tidal energy, limitations of tidal energy. **Energy from ocean waves:** Wave energy conversion, Wave energy technologies, advantages, and disadvantages.	**08 Hrs. / L3**
Module 5 **Ocean Thermal Energy Conversion:** Principle of working, Rankine cycle, OTEC power stations in the world, problems associated with OTEC, case studies. **Geothermal energy:** Introduction, Principle of working, types of geothermal stations with schematic diagram Estimates of Geothermal Power, Nature of geothermal fields, Geothermal resources, Hydrothermal, Resources Geo pressured resources, Hot dry rock resources of petro-thermal systems, Magma Resources-Interconnection of geothermal fossil systems, Advantages, and disadvantages of geothermal energy over other energy forms, Geothermal stations in the world.	**08 Hrs. / L3**

COURSE OUTCOMES: Upon completion of this course, student will be able to:

CO811.1	Evaluate the need for alternative energy sources and use advanced techniques for measuring and interpreting solar radiation data using specialized instruments.
CO811.2	Analyze the geometric aspects of solar radiation and evaluate the design and functionality of various solar thermal and photovoltaic systems.
CO811.3	Evaluate the potential and challenges of wind energy and biomass energy by analyzing the design and characteristics of wind machines and biogas plants.
CO811.4	Analyze the advantages and disadvantages of hydroelectric, tidal, and wave energy
CO811.5	Analyze the principles and operational mechanisms of ocean thermal energy conversion and geothermal energy systems

Textbooks:

1. Solar Energy Principles, Thermal Collection &Storage, S.P. Sukhatme: Tata McGraw Hill Pub., New Delhi.
2. Non-Conventional Energy Sources, G. D. Rai, New Delhi.
3. Renewable Energy, power for a sustainable future, Godfrey Boyle,2004
4. The Generation of electricity by wind, E. W. Golding.
5. Non-Conventional Energy Resources by B.H. Khan, Tata McGraw Hill Pub.,2009

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Reference books:

1. Fundamentals of Renewable Energy Resources by G.N.Tiwari, M.K.Ghosal, Narosa Pub., 2007.
2. Non-Conventional Energy Resources by B.H. Khan, Tata McGraw Hill Pub., 2009.
3. Non-Conventional Energy Resources by Shobh Nath Singh, Pearson India., 2016
4. Environmental Justice in India: The National Green Tribunal, By Gitanjali Nain Gill, Routledge (2016).
5. Ref: The Oxford Handbook of Comparative Environmental Law, edited by Emma Lees, Jorge E. ViÒuales, Oxford University Press (2019)

E-Books / Web References

1. https://www.youtube.com/watch?v=iZyzvDj6Y3c&list=PLwdnzlV3ogoXUifhvYB65lLJCZ74o_fAk&index=2
2. https://www.youtube.com/watch?v=Og4LEc7SpdQ&list=PLwdnzlV3ogoXUifhvYB65lLJCZ74o_fAk&index=3
3. https://www.youtube.com/watch?v=L3AEXdvtIkk&list=PLwdnzlV3ogoXUifhvYB65lLJCZ74o_fAk&index=19
4. https://www.youtube.com/watch?v=TUu40kDqcEc&list=PLwdnzlV3ogoXUifhvYB65lLJCZ74o_fAk&index=24

Scheme of Examination:

Semester End Examination (SEE): SEE Question paper is to be set for 100 marks and the marks scored will be proportionately reduced to 50. There will be two full questions (with a maximum of four sub questions) from each module carrying 20 marks each. Students are required to answer any **five full questions** choosing at least **one full question from each module.**

Continuous Internal Evaluation (CIE): Three Tests are to be conducted for 40 marks each. An average of three tests is taken. CIE is executed by way of one quiz / Alternate Assessment Tools (AATs), and an average of three tests. One quiz is to be conducted and evaluated for 10 marks

Some possible AATs: Assignments/ group activity / any other.

Typical Evaluation pattern for regular courses is shown in Table 2.

Table 2: Distribution of weightage for CIE & SEE of Regular courses

	Component	Marks	Total Marks
CIE	CIE Test-1	**40**	**50**
	CIE Test-2	**40**	
	CIE Test-3	**40**	
	AAT/Quiz	**10**	
SEE	Semester End Examination	**50**	**50**
Grand Total			**100**

CO/PO Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO811.1	3	2	2			2	2					2		3	
CO811.2	3	2	2			2	2					2		3	
CO811.3	3	2	2			2	2					2		3	
CO811.4	3	2	2			2	2					2		3	
CO811.5	3	2	2			2	2					2		3	
Average	**3**	**2**	**2**			**2**	**2**					**2**		**3**	

Low - 1: Medium - 2: High – 3

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SEMESTER – VIII

Course: THERMAL MANAGEMENT OF ELECTRONIC EQUIPMENTS

Course Code	21MED812	CIE Marks	50
Hours/Week (L: T: P)	3 : 0 : 0	SEE Marks	50
No. of Credits	3	Examination Hours	03

Prerequisites: Heat Transfer

Course Objectives: Students will be taught :

CLO1	The semiconductor technology and the importance of thermal management in electronics
CLO2	Various thermal transfer process and properties of the surfaces affecting the thermal management
CLO3	Advanced cooling methodologies and thermal design
CLO4	To perform and analyze computer simulations for solution of real-world thermal management problems

Content	No. of Hours/ RBT levels
Module 1 **Introduction**: Semiconductor Technology Trends. Temperature –Dependent Failures, Importance of heat transfer in electronics. Thermal design process. Heat Transfer mechanisms	**08 Hours / L1, L2, L3**
Module 2 **Heat Conduction Equation-Fins and Heat sinks Radiation Heat Transfer**: General heat Conduction equation. Boundary and initial conditions. Steady state, Transient heat, Micro scale heat conduction. Fin equation, Heat sinks, Blackbody radiation, Radiation heat transfer from plate-fin heat sinks.	**08 Hours / L1, L2, L3**
Module 3 **Convective Heat Transfer:** Velocity and thermal boundary layer. Friction coefficient, Heat transfer coefficient. External and Internal flows, Natural convection heat transfer	**08 Hours / L1, L2, L3**
Module 4 **Advanced Cooling Technologies:** Experimental Techniques and Thermal design: Heat pipes, Heat pipe selection and modeling, Jet impingement on flat surfaces and heatsinks, Liquid immersion cooling, Thermo-syphons, Loop heat pipes, Thermoelectric coolers, cooling using phase change– cooling with PCM materials, piezoelectric fans, Electro hydrodynamic flow, Synthetic Jets, Single phase and two-phase flow micro channels-Thermal design	**08 Hours / L1, L2, L3**
Module 5 **Temperature measurement:** Thermocouples, overview, reference junction, proper connections, types, special limits of error wire, time constants, sheathing, potential problems, DAQ setup	**08 Hours / L1, L2, L3**

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RTDs: overview, bridges, calibration, accuracy, response time, potential problems **Thermistors**: Infrared Thermometry fundamentals, emissivity determination, field of view, Other Non-electronic measurement, thin-film heat flux gauge Temperature Controllers How to Choose; Standards, cost, accuracy, stability, sensitivity, size, contact/non-contact, temperature range, fluid type **Thermal interface materials**, types, ideal and actual TIM, TIM test methods	

COURSE OUTCOMES: Upon completion of this course, student will be able to:

CO812.1	Apply advanced heat transfer principles to design and optimize thermal management solutions for electronic components, devices, and systems to enhance performance and reliability.
CO812.2	Apply the concept of thermal resistance in designing and optimizing thermal management systems to improve heat dissipation and component efficiency.
CO812.3	Interpret first-order analyses of heat transfer from electronic systems to develop effective cooling strategies and improve system performance
CO812.4	Evaluate advanced cooling technologies, discussing their impact on electronic system efficiency and thermal management.
CO812.5	Compare various temperature measurement instruments and thermal interface materials to select and implement optimal solutions for precise temperature control and effective thermal management.

Textbooks:

1. **Shabany Younes** "Heat Transfer-Thermal Management in Electronics", CRC Press, First Edition, 2010
2. **Steinberg, Dave S., "Cooling Techniques for Electronic Equipment",** John Wiley & Sons, 1991
3. Ravi Kandasamy and Arun S. Mujumdar, Thermal Management of Electronic Components, Lambert Academic Publishing, 2010.

Reference books:

1. G N Ellison, Van Nostrand Reinhold, "Thermal Computations for Electronic Equipment", First Edition, 1984
2. A D Kraus and A Bar Cohen, "Thermal Analysis and Control of Electronic Equipment", McGraw-Hill, Hemisphere, Second Edition, 1983

E-Books / Web References

1. https://www.pdfdrive.com/thermal-management-of-microelectronic-equipment-heat-transfer-theory-analysis-methods-and-design-practices-e185972760.html
2. https://www.pdfdrive.com/heat-pipe-design-and-technology-modern-applications-for-practical-thermal-management-d176024584.html

MOOCs

1. NPTEL Course: "Electronic enclosures Thermal issues" (https://onlinecourses.nptel.ac.in/noc21_ee46/preview)
2. Free Video Lectures: "Thermal Design and Cooling", (https://www.youtube.com/watch?v=m7LVcog4bpc)

Scheme of Examination:

Semester End Examination (SEE):

SEE Question paper is to be set for 100 marks and the marks scored will be proportionately reduced

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to 50. There will be two full questions (with a maximum of four sub questions) from each module carrying 20 marks each. Students are required to answer any **five full questions** choosing at least **one full question from each module.**

Continuous Internal Evaluation (CIE):

Three Tests are to be conducted for 40 marks each. The average of the three tests are taken for computation of CIE. The assignment component would be for 10 marks. CIE is executed by way of quizzes / Alternate Assessment Tools (AATs), and three tests.

Some possible methods of assessment for assignments: Assignments / Oral presentations / Group activity/Projects.

Typical Evaluation pattern for regular courses is shown in Table 2.

Table 2: Distribution of weightage for CIE & SEE of Regular courses

	Component	Marks	Total Marks
CIE	CIE Test-1	**40**	**50**
	CIE Test-2	**40**	
	CIE Test-3	**40**	
	Assignment/Quiz /AAT	**10**	
SEE	Semester End Examination	**100**	**50**
Grand Total			**100**

CO/PO Mapping															
CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO812.1	3	2	1	1	1	1	1			1		1		1	
CO812.2	3	2	1	1	1	1	1			1		1		1	
CO812.3	3	2	1	1	1	1	1			1		1		1	
CO812.4	3	2	1	1	1	1	1			1		1		1	
CO812.5	3	2	1	1	1	1	1			1		1		1	
Average	3	2	1	1	1	1	1			1		1		1	

Low - 1: Medium - 2: High - 3

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SEMESTER – VIII

Course: OPERATIONS RESEARCH

Course Code	21MED813	CIE Marks	50
Hours/Week (L: T: P)	2 : 2 : 0	SEE Marks	50
No. of Credits	3	Examination Hours	03

Prerequisites: Basic Mathematics

Course Objectives: The students will be taught to:

CLO1	Convert the real life situations to mathematical form and find optimal solutions.
CLO2	Draw the network showing the flow of activities and determine the completion of project.
CLO3	Predict the characteristics of queues like probability of waiting, waiting times, number of customers etc.

Content	No. of Hours/ RBT levels
Module 1 **Introduction:** Definition and Scope of OR, Applications, Advantages and Disadvantages, Phases of OR. **Linear Programming:** Formulation of LP problems and solution by graphical method.	**08Hours / L1, L2, L3**
Module 2 **Solution to LP problems:** Simplex method, Big-M method, Degeneracy in LPP, Concept of Duality, Solution to primal from dual	**08 Hours / L1, L2, L3**
Module 3 **Transportation Models:** Formulation of transportation matrix (both balanced and unbalanced), Initial basic feasible solution (NWCR and VAM only), Optimality by MoDi method, Degeneracy and resolving degeneracy in TP, Maximization in TP. **Assignment Problems:** Solution by Hungarian method, Variation in Assignment Problems (Unbalanced, Restricted Assignments)	**08 Hours / L1, L2, L3**
Module 4 **PERT-CPM techniques:** Differences between PERT and CPM, Network construction, Node numbering using Fulkerson's rule, Determination of critical path and duration, CPM –Prediction of project completion (No numericals on crashing of networks). **Game Theory:** Definitions of terminologies used in Game theory, Formulation of payoff matrix, Maximin and Minimax principles for Games of Pure strategy, Algebraic method for games of mixed strategy, Graphical method to solve 2xn and mx2 games, Dominance principle for mxn games.	**08 Hours / L1, L2, L3**
Module 5 **Queuing Theory:** Introduction, Characteristics of Queueing systems, Representation of Queueing models by Kendal's Notation, Numericals on single	**08 Hours / L1, L2, L3**

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channel queueing systems only. **Sequencing:** Definitions and assumptions, Sequencing of 'n' jobs on 'm' (m=2, 3 and greater than 3) machines, Graphical method for sequencing of '2' jobs on 'm' machines.	

COURSE OUTCOMES: Upon completion of this course, student will be able to:

CO813.1	Formulate real-life problems using concepts Linear Programming and obtain the optimum solutions.
CO813.2	Formulate real-life transportation and assignment problems to find the optimum solution.
CO813.3	Construct the precedence diagram to find the duration of project.
CO813.4	Formulate the competitive situations to find the winner of the game.
CO813.5	Analyze the Queueing model for satisfaction of customer.
CO813.6	Determine the sequence of jobs so as to minimize the total elapsed time for completion.

Textbooks:

1. **S D Sharma**, Operations Research, KNBN publishers
2. **Hamdy A.Taha**, Operations Research, PHI Private Limited, Seventh Edition, 2006

Reference books:

1. **A M Natarajan, P Balasubramani,** Operations Research, Pearson Education, 2005
2. **Hillier and Lieberman,** Introduction to Operations Research, McGraw Hill, 8th edition

E-Books / Web References

1. https://www.bbau.ac.in/dept/UIET/EME-601%20Operation%20Research.pdf
2. https://www.pdfdrive.com/introduction-to-operations-research-d14995994.html

MOOCs

1. https://nptel.ac.in/courses/110106062
2. https://nptel.ac.in/courses/111107128

Scheme of Examination:

Semester End Examination (SEE):

SEE Question paper is to be set for 100 marks and the marks scored will be proportionately reduced to 50. There will be two full questions (with a maximum of four sub questions) from each module carrying 20 marks each. Students are required to answer any **five full questions** choosing at least **one full question from each module.**

Continuous Internal Evaluation (CIE):

Three Tests are to be conducted for 40 marks each. CIE is executed by way of three tests and a quiz / Alternate Assessment Tools (AATs) for 10 marks.

Some possible AATs:

Assignments/ group activity / any other.

Typical Evaluation pattern for regular courses is shown in Table 2.

Table 2: Distribution of weightage for CIE & SEE of Regular courses

	Component	Marks	Total Marks
CIE	CIE Test-1	**40**	**50**
	CIE Test-2	**40**	
	CIE Test-3	**40**	
	Quiz /AAT	**10**	
SEE	Semester End Examination	**50**	**50**
Grand Total			**100**

CO/PO Mapping															
CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO813.1	2	2	1	1		1						1			2
CO813.2	2	2	1	1		1						1			2
CO813.3	2	2	1	1		1					2	1			2
CO813.4	2	2	1	1		1					2	1			2
CO813.5	2	2	1	1		1						1			2
CO813.6	2	2	1	1		1						1			2
Average	2	2	1	1		1					2	1			2

Low - 1: Medium - 2: High - 3

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SEMESTER – VIII

Course: Supply Chain Management

Course Code	**21MED814**	**CIE Marks**	**50**
Hours/Week (L: T: P)	**3 : 0 : 0**	**SEE Marks**	**50**
No. of Credits	**3**	**Examination Hours**	**03**

Prerequisites: Management and Entrepreneurship

Course Objectives: This course will enable the students to:

CLO1	Understand the stages, decision phases and process views in supply chain management
CLO2	Identify the major drivers of supply chain performance.
CLO3	Describe inventory management, transportation and the key factors considered in designing a distribution network.
CLO4	Develop a framework for making network design decisions and coordination in supply chain.
CLO5	Discuss the importance of supply chain restructuring and the future of IT in supply chain management.

Content	No. of Hours/ RBT levels
Module 1 **Introduction to Supply Chain:** Fundamentals of Supply Chain, Stages, Objectives, Importance, Decision Phases and Process Views in Supply chain. Competitive and Supply Chain strategies, Achieving strategic fit, Supply Chain performance measures. **Case Studies:** Example- Toyota: A global Auto Manufacturer, Amazon.com: An E-Business.	**8 Hours / L1, L2, L3**
Module 2 **Supply Chain Drivers and Metrics:** Drivers of Supply Chain Performance, Framework for structuring Drivers, Facilities, Inventory, Transportation, Information, Sourcing and Pricing. **Case Studies:** Example- Seven Eleven Japan Company, E- Sourcing at Marico.	**8 Hours / L1, L2, L3**
Module 3 **Material Flow in Supply Chains:** Inventory Management- Types of Inventory, Inventory-related Costs. Transportation- Drivers of Transportation Decisions Comparison of modes of transportation on Supply Chain performance measures. **Designing Distribution Networks and Application to E-Business**: Role of distribution, factors influencing distribution network design, design options for a distribution network, E-Business and the distribution network.	**8 Hours / L1, L2, L3**
Module 4 **Network Design in the Supply Chain:** Role of network design in the supply chain, factors influencing network design decisions, framework for network design decisions. **Coordination in a supply chain:** Lack of supply chain coordination and Bullwhip Effect, Effect on performance due to lack of coordination, obstacles to coordination in a supply chain.	**8 Hours / L1, L2, L3**

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Module 5	
Supply Chain Restructuring: Supply Chain Mapping, Supply Chain process restructuring, Postponement Case Studies: Hewlett-Packard: postponement of product differentiation, Benetton: postponement by re sequencing of processes. **Information Technology in supply chain:** Role of IT in a supply chain, Customer relationship management, Internal supply chain management, Supplier relationship management, Future of IT in supply chain and Risk management in IT.	**8 Hours / L1, L2, L3**

COURSE OUTCOMES: Upon completion of this course, student will be able to:

CO814.1	Analyze the fundamentals and scope of supply chain management and evaluate their significance in business operations.
CO814.2	Assess the roles and performance of various drivers in supply chain management and determine their impact on overall efficiency.
CO814.3	Design material flow, inventory management, and transportation systems for effective distribution networks in E-business, and optimize their performance.
CO814.4	Evaluate the role of network design and coordination in supply chain management and formulate strategies for enhancing integration and performance.
CO814.5	Assess the importance of supply chain restructuring and analyze the impact of information technology on supply chain operations and efficiency.

Textbooks:

3. **Sunil Chopra and Peter Meindl**, Supply Chain Management, 3rdEdition, Pearson Education 2007.
4. **Janat Shah**, Supply Chain Management, Text and Cases, Pearson Education 2009.

Reference books:

5. Supply Chain Management Theories & Practices, R. P. Mohanty, S. G. Deshmukh, Dreamtech Press, 19-A, Anari Road, Daryaganj, New Delhi.
6. Total Supply Chain Management by Ron Basu, J. Nevan Wright.
7. Supply Chain Management, Chopra, Pearson
8. David Simchi-Levi, Philp Kamintry and Edith Simchy Levy, Designing and Managing the Supply Chain - Concepts Strategies and Case Studies, 2nd Edition, Tata-McGraw Hill.

E-Books / Web References

4. **E - Books:** "Strength of Materials", (http://freeengineeringbooks.com/Civil/Strength-of-Material-Books.php)
5. https://www.pdfdrive.com/global-supply-chain-management-and-international-logistics-d162358148.html
6. https://www.pdfdrive.com/innovative-methods-in-logistics-and-supply-chain-management-d34408414.html

NPTEL

4. NPTEL Course: "Global Supply Chain Management" https://nptel.ac.in/courses/110108056
5. NPTEL Course: "Operations and Supply Chain Management" https://nptel.ac.in/courses/110106045
6. NPTEL Course: "Modelling and Analytics for Supply Chain Management'' https://nptel.ac.in/courses/110105141

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Scheme of Examination:

Semester End Examination (SEE):

SEE Question paper is to be set for 100 marks and the marks scored will be proportionately reduced to 50. There will be two full questions (with a maximum of four sub questions) from each modulecarrying 20 marks each. Students are required to answer any **five full questions** choosing at least **one full questionfrom each module.**

Continuous Internal Evaluation (CIE):

Three Tests are to be conducted for 40 marks each. Average of three tests is taken. CIE is executed by way of one quiz / Alternate Assessment Tools (AATs), and average of three tests. One quiz is conducted and evaluated for 10 marks.

Some possible AATs:

Assignments/ group activity / any other.

Typical Evaluation pattern for regular courses is shown in Table 2.

Table 2: Distribution of weightage for CIE & SEE of Regular courses

	Component	Marks	Total Marks
CIE	CIE Test-1	**40**	**50**
	CIE Test-2	**40**	
	CIE Test-3	**40**	
	Quiz 2/AAT	**10**	
SEE	Semester End Examination	**50**	**50**
Grand Total			**100**

CO/PO Mapping															
CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO814.1	2	2	1			3	3	1				2			3
CO814.2	2	2	1			3	3	1				2			3
CO814.3	2	2	1			3	3	1				2			3
CO814.4	2	2	1			3	3	1				2			3
CO814.5	2	2	1			3	3	1				2			3
Average	**2**	**2**	**1**			**3**	**3**	**1**				**2**			**3**

Low - 1: Medium - 2: High - 3

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SEMESTER – VIII

Course: Tribology

Course Code	21MED821	CIE Marks	50
Hours/Week (L: T: P)	2 : 2 : 0	SEE Marks	50
No. of Credits	3	Examination Hours	03

Prerequisites: Fluid Mechanics

Course Objectives: Guide the students to,

CLO1	Understand the knowledge and importance of Tribology in Design, friction, wear and lubrication aspects of machine components.
CLO2	Demonstrate basic understanding of friction, lubrication, and wear processes.
CLO3	Understand the principles of lubrication, lubrication regimes, theories of hydrodynamic and the advanced lubrication techniques.
CLO4	Select compatible materials for minimizing friction and wear.

Content	No. of Hours/ RBT levels
Module 1 **Introduction to tribology:** Historical background, practical importance, and subsequent use in the field. Lubricants: Types and specific field of applications. Properties of lubricants, viscosity, its measurement, effect of temperature and pressure on viscosity, lubrication types, standard grades of lubricants, and selection of lubricants.	**08** **L1,L2**
Module 2 **Friction:** Origin, friction theories, measurement methods, friction of metals and non-metals. **Introduction of Wear and Wear Mechanism:** Introduction of Wear, Pitting, Classification and mechanisms of wear- Abrasive wear- Two – Body Abrasion, Three body abrasion, Adhesive Wear, Laws of adhesive wear by Archard, Corrosive Wear, Fatigue wear, Erosive wear, Fretting wear, Percussion,, delamination theory, debris analysis, wear testing methods -Abrasive wear test, Rolling sliding wear test, Pin on disk wear test.	**08** **L1,L2**
Module 3 **Hydrodynamic journal bearings:** Friction forces and power loss in a lightly loaded journal bearing, Petroff's equation, mechanism of pressure development in an oil film, and Reynold's equation in 2D.	**08** **L1,L2,L3**

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Hydrostatic Lubrication: Introduction to hydrostatic lubrication, hydrostatic step bearings, load carrying capacity and oil flow through the hydrostatic step bearing, numerical examples.	
Module 4 **Tribological Components and Applications**, Common Tribological Components, Sliding-Contact Bearings, Rolling-Contact Bearings, Seals, Gears, BioMEMS, Industrial Applications-Automotive Engines, Magnetic Storage Devices. **Modern Applications of Tribology**- Biomedical (Bio tribology), Nanotribology, Green Tribology.	**08** **L1,L2,L3**
Module 5 **Bearing Materials:** Commonly used bearings materials, and properties of typical bearing materials. Advantages and disadvantages of bearing materials. **Introduction to Surface engineering:** Concept and scope of surface engineering. **Surface modification –**transformation hardening, surface melting, thermo chemical processes. **Surface Coating –**plating, fusion processes, vapor phase processes. Selection of coating for wear and corrosion resistance.	**08** **L1,L2**

COURSE OUTCOMES: Upon completion of this course, student will be able to:

CO821.1	*Understand* the fundamentals of tribology and associated parameters.
CO821.2	*Apply* concepts of tribology for the wear and friction analysis and design of components experiencing relative motion.
CO821.3	*Analyse* the requirements and design hydrodynamic journal and Hydrostatic bearings for a given application.
CO821.4	*Investigate* the prevalent tribological components utilized in industrial applications.
CO821.5	*Select* proper bearing materials and lubricants for a given tribological application.

Textbooks:

1. ”Introduction to Tribology”, B. Bhushan, John Wiley & Sons, Inc., New York, 2002
2. “Engineering Tribology”, PrasantaSahoo, PHI Learning Private Ltd, New Delhi, 2011.
3. “Engineering Tribology”, J. A. Williams, Oxford Univ. Press, 2005.

Reference books:

1. “Introduction to Tribology in bearings”, B. C. Majumdar, Wheeler Publishing.
2. “Tribology, Friction and Wear of Engineering Material”, I. M.Hutchings, Edward Arnold, London,1992
3. “Engineering Tribology”, G. W. Stachowiak and A. W. Batchelor, Butterworth-Heinemann,1992.
4. “Friction and Wear of Materials”, Ernest Rabinowicz, John Wiley & sons,1995.
5. “Basic Lubrication Theory”, A. Cameron, Ellis Hardwoods Ltd., UK.
6. “Handbook of tribology: materials, coatings and surface treatments”, B.Bhushan, B.K. Gupta, McGraw-Hill,1997.

E-Books / Web References

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1. https://www.pdfdrive.com/introduction-to-tribology-d52737530.html
2. https://www.pdfdrive.com/tribology-friction-and-wear-of-engineering-materials-d158254335.html

MOOCs

1. https://nptel.ac.in/courses/112102015
2. https://nptel.ac.in/courses/112102014
3. https://onlinecourses.nptel.ac.in/noc20_mm12/preview

Scheme of Examination:

Semester End Examination (SEE):

SEE Question paper is to be set for 100 marks and the marks scored will be proportionately reduced to 50. There will be two full questions (with a maximum of four sub questions) from each module carrying 20 marks each. Students are required to answer any five full questions choosing at least one full question from each module.

Continuous Internal Evaluation (CIE):

Three Tests are to be conducted for 40 marks each. Average of three tests is taken. CIE is executed by way of one quiz / Alternate Assessment Tools (AATs), and average of three tests. One quiz is to be conducted and evaluated for 10 marks

Some possible AATs:

Assignments/ group activity / any other.

Typical Evaluation pattern for regular courses is shown in Table 2.

Table 2: Distribution of weightage for CIE & SEE of Regular courses

	Component	Marks	Total Marks
CIE	CIE Test-1	**40**	**50**
	CIE Test-2	**40**	
	CIE Test-3	**40**	
	Quiz /AAT	**10**	
SEE	Semester End Examination	**50**	**50**
Grand Total			**100**

CO/PO Mapping															
CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO821.1	2	2	1	1		2	1					1	1		
CO821.2	2	2	1	1		2	1					1	1		
CO821.3	2	2	1	1		2	1					1	1		
CO821.4	2	2	1	1		2	1					1	1		
CO821.5	2	2	1	1		2	1					1	1		
Average	**2**	**2**	**1**	**1**		**2**	**1**					**1**	**1**		

Low - 1: Medium - 2: High - 3

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SEMESTER – VIII

Course: COMPUTATIONAL FLUID DYNAMICS

Course Code	**21MED822**	**CIE Marks**	**50**
Hours/Week (L: T: P)	**2 : 2 : 0**	**SEE Marks**	**50**
No. of Credits	**3**	**Examination Hours**	**03**

Prerequisites: Fluid Mechanics

Course Objectives: The students will be taught:

CLO1	One dimensional (1D) computation by finite difference method (FDM), finite element method (FEM) and finite volume method (FVM)
CLO2	The basic governing equations of CFD, different finite difference schemes and accuracy of FD solution
CLO3	Different solution methodologies for FD equations and stability analysis

Content	No. of Hours/ RBT levels
Module 1 **Introduction to CFD**: The need for computer simulations of fluid flows; Brief history of CFD, Relative merits with respect to Experimental and Theoretical Fluid Dynamics, Concept of Transport process – Importance in design, major elements of a CFD Code, - Preprocessor, Flow Equation Solver and Postprocessor - One-dimensional computations by finite difference methods, finite element methods and finite volume methods; Boundary conditions – Neumann and Dirichlet boundary conditions.	**08 Hours / L3**
Module 2 **Governing Equations for CFD:** Brief introduction to Vectors & Tensors, Mathematical behaviour of partial differential equations relevant to CFD, Conservation Equations for mass, momentum and energy in cartesian coordinates, equation of state, Navier-Stokes equations for a Newtonian fluid, general transport equations, fluid flow equations.	**08 Hours / L3**
Module 3 **The Finite Volume Method for Diffusion Problems**: one, two and three - dimensional steady state diffusion; Finite Volume Method for Convection-Diffusion Problems: Steady one-dimensional convection and diffusion, differencing scheme, power law scheme, higher order differencing scheme for convection-diffusion problems.	**08 Hours / L3**
Module 4 **Solution Algorithms for Pressure-Velocity Coupling in steady flows and Discretised Equations:** the staggered grid, the momentum equations, SIMPLE, SIMPLER, SIMPLEC and PISO algorithm, general comments on the algorithms, Tri-diagonal matrix algorithm.	**08 Hours / L3**

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Module 5	08 Hours / L3
Finite Volume Method for Unsteady Flows: One-dimensional unsteady heat conduction, Explicit scheme, Crank-Nicolson Scheme, fully implicit scheme, Discretization of transient convection-diffusion equation. Solution procedures for unsteady flow calculations.	

COURSE OUTCOMES: Upon completion of this course, student will be able to:

CO822.1	Understand the importance of computational fluid dynamics in solving fluid flow problems and Discern the concepts of 1D computations by FDM, FEM, and FVM
CO822.2	Explain basic governing equations of CFD and employ different finite difference schemes
CO822.3	Explicate the application of FVM to solve convection and diffusion problems
CO822.4	Elucidate different solution methodologies used for solving and hyperbolic, parabolic and elliptic governing equations
CO822.5	Analyze various FVM schemes applied in solving unsteady flows

Textbooks:

1. **T J Chung,** Computational Fluid Dynamics Production Technology Volume-II, Dhanpat Rai Publications, 2017.
2. **John D Anderson, Computational Fluid Dynamics, McGraw-Hill International Edition, 1995.**

Reference books:

1. J. Tu, G. Yeoh, C. Liu, Computational Fluid Dynamics: A Practical Approach, 2nd Edition, 2013
2. Jiyuan Tu, Guan Heng Yeoh and Chaoqun Liu, Butterworth- Heineman ,"Computational Fluid Dynamics – A Practical Approach", Third Edition, 2008.

E-Books / Web References

1. https://www.pdfdrive.com/page-2-computational-fluid-dynamics-page-3-john-f-wendt-ed-computational-fluid-dynamics-d39904215.html

MOOCs

1. https://nptel.ac.in/courses/112105045
2. Introduction to CFD - Course (nptel.ac.in)

Scheme of Examination:

Semester End Examination (SEE):

SEE Question paper is to be set for 100 marks and the marks scored will be proportionately reduced to 50. There will be two full questions (with a maximum of four sub questions) from each module carrying 20 marks each. Students are required to answer any **five full questions** choosing at least **one full question from each module.**

Continuous Internal Evaluation (CIE):

Three Tests are to be conducted for 40 marks each. The average of the three tests are taken for computation of CIE. The assignment component would be for 10 marks. CIE is executed by way of quizzes / Alternate Assessment Tools (AATs), and three tests.

Some possible methods of assessment for assignments: Assignments / Oral presentations / Group activity/Projects.

Typical Evaluation pattern for regular courses is shown in Table 2.

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Table 2: Distribution of weightage for CIE & SEE of Regular courses

	Component	Marks	Total Marks
CIE	CIE Test-1	**40**	**50**
	CIE Test-2	**40**	
	CIE Test-3	**40**	
	Assignment/Quiz /AAT	**10**	
SEE	Semester End Examination	**100**	**50**
Grand Total			**100**

CO/PO Mapping															
CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO822.1	3	2	2	1	2	1	1	-	-	1	-	1	-	2	-
CO822.2	3	2	2	1	2	1	1	-	-	1	-	1	-	2	-
CO822.3	3	2	2	1	2	1	1	-	-	1	-	1	-	2	-
CO822.4	3	2	2	1	2	1	1	-	-	1	-	1	-	2	-
CO822.5	3	2	2	1	2	1	1	-	-	1	-	1	-	2	-
Average	3	2	2	1	2	1	1	-	-	1	-	1	-	2	-

Low - 1: Medium - 2: High - 3

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SEMESTER – VIII

Course: Industry 4.0

Course Code	21MED823	CIE Marks	50
Hours/Week (L: T: P)	3: 0 : 0	SEE Marks	50
No. of Credits	3	Examination Hours	03

Course Objectives: This course will enable the students to,

CLO1	Identify the drivers and enablers of Industry 4.0
CLO2	Outline the various systems needed to convert the enterprises into Industry 4.0
CLO3	Analyze the technologies involved in Industry 4.0 for developing a sustainable environment.
CLO4	Identify the different views for generating the taxonomy of industry 4.0.
CLO5	Discuss the case studies and solve the problems for industry 4.0.

Content	No. of Hours/ RBT levels
Module 1 **Introduction to Industry 4.0:** Historical evolution of industry, Industry 4.0: origin and key understandings, Industry 4.0 design principles, Current Status and Future Trends. **The industry 4.0 pillars:** Collaborative robots, Augmented reality, Simulation modeling, Additive manufacturing, integration (Horizontal and vertical value chain), Cybersecurity, IoT, cloud computing, Big Data, Artificial Intelligence, 5G network.	**08 Hours / L1, L2, L3**
Module 2 **Transforming a small and medium enterprise (SMEs) into Industry 4.0**: Automation and improving of process, migration, and investment return, taxes, Standardisation, economy, legal challenges in Industry 4.0, Future trends: Industry 5.0 or Society 5.0, Circular economy.	**08 Hours / L1, L2, L3**
Module 3 **Industry 4.0 Technologies**: Cyber-physical systems, Cloud manufacturing, Big Data analytics, Augmented reality, Smart sensors, Location detection, Industrial Internet of Things (IIoT), Additive manufacturing. Environmental Management in Industry 4.0 and potential technologies, Challenges for environmental and sustainable beneficiation through technologies 4.0.	**08 Hours / L1, L2, L3**
Module 4 **A Taxonomy of Industry 4.0 and Related Technologies:** Introduction, Methodology used for generating the taxonomy, Taxonomy of industry 4.0, Strategic view of Industry 4.0, Managerial view, Technical view, Human resource view.	**08 Hours / L1, L2, L3**

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Module 5	
Applications and Case Studies, Industry 4.0 laboratories, IIoT case studies, Case studies from smart industries, factories: manufacturing, production, design and IT. Business issues in Industry 4.0.Industry 4.0 in the automobile industry in European countries. Case Study -Renault - An industry 4.0, Industrial company transformation into Smart Factory with an accent on internal logistics and production.	**08 Hours / L1, L2, L3**

COURSE OUTCOMES: Upon completion of this course, student will be able to

CO823.1	Analyze the evolution and constituting elements of Industry 4.0 and evaluate their impact on modern manufacturing and business processes.
CO823.2	Identify and assess the key factors responsible for transforming small and medium enterprises into Industry 4.0 and develop strategies for successful implementation.
CO823.3	Evaluate various technologies enabling Industry 4.0 and synthesize approaches to create a sustainable environment through these technologies.
CO823.4	Analyze the different perspectives representing the taxonomy of Industry 4.0 and formulate a comprehensive understanding of its framework.
CO823.5	Interpret various case studies associated with Industry 4.0 and evaluate their outcomes to derive best practices and lessons learned.

Textbooks:

1. Alasdair Gilchrist, Industry 4.0: The Industrial Internet of Things, 1st Edition, Apress, 2017.
2. Elena G. Popkova Yulia V. Ragulina, Aleksei V. Bogoviz, Industry 4.0. Industrial Revolution of 21st Century, 1st Edition, Springer, 2019.

Reference books:

1. Fran Yanez, The 20 Key Technologies of Industry 4.0 and Smart Factories: The Road to the Digital Factory of the Future, Independent Publisher, 2017.

E-Books / Web References

1. https://www.ibm.com/in-en/topics/industry-4-0#:~:text=Industry%204.0%20is%20revolutionizing%20the,facilities%20and%20throughout%20their%20operations.
2. https://www2.deloitte.com/content/dam/Deloitte/de/Documents/consumer-industrial-products/Deloitte-Industry-4-0-and-manufacturing-ecosystems.pdf
3. https://library.oapen.org/bitstream/handle/20.500.12657/43836/external_content.pdf?sequence=1&isAllowed=y
4. https://www.thedigitaltransformationpeople.com/channels/the-case-for-digital-transformation/renault-an-industry-4-0-case-study.
5. https://www.researchgate.net/publication/352312272_Industry40A case study of industrial company transformation into Smart Factory with an accent on internal logistics and production

Scheme of Examination: (Theory courses)

Semester End Examination (SEE):

SEE Question paper is to be set for 100 marks and the marks scored will be proportionately reduced to 50. There will be two full questions (with a maximum of four sub questions) from each module carrying 20 marks each. Students are required to answer any **five full questions** choosing at least **one full question from each module.**

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Continuous Internal Evaluation (CIE):

Three Tests are to be conducted for 40 marks each. The average of the three tests are taken for computation of CIE on a scale of 40.

CIE is executed by way of two quizzes / Other Assessment Tools (OATs), and three tests.

Some possible AATs: Assignments / Oral presentations / Group activity/Projects

Typical Evaluation pattern for regular courses is shown in Table 2.

Table 2: Distribution of weightage for CIE & SEE of Regular courses

	Component	Marks	Total Marks
CIE	CIE Test-1	**40**	**50**
	CIE Test-2	**40**	
	CIE Test-3	**40**	
	QUIZ/OAT	**10**	
SEE	Semester End Examination	**100**	**50**
		Grand Total	**100**

CO/PO Mapping															
CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO823.1	3	2	2	1		1	1	1				1			2
CO823.2	3	2	2	1		1	1	1				1			2
CO823.3	3	2	2	1		1	2	1				1			2
CO823.4	3	2	2	1		1	1	1				1			2
CO823.5	3	2	2	1		1	1	1				1			2
Average	3	2	2	1		1	1	1				1			2

Low - 1: Medium - 2: High - 3

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SEMESTER – VIII

Course: NON-TRADITIONAL MACHINING

Course Code	22MED824	CIE Marks	50
Hours/Week (L: T: P)	3 : 0 : 0	SEE Marks	50
No. of Credits	3	Examination Hours	03

Prerequisites: Manufacturing Process (Integrated)

Course Objectives:

CLO1	Understand the need of Non Traditional Machining Processes and able to Classify various processes.
CLO2	Recognize the role of mechanical energy in non-traditional manufacturing processes.
CLO3	Understand the concept of machining the hard material using Chemical energy and Electrochemical energy.
CLO4	Describe the concepts of Electrical discharge and plasma arc machining process in non-traditional machining process.
CLO5	Determine the basic principles and operation of electron beam machining and laser beam machining.

Content	No. of Hours/ RBT levels
Module 1 **INTRODUCTION TO NTM** Introduction to Non-traditional machining, Need for Non-traditional machining process, Comparison between traditional and non-traditional machining. General classification Non-traditional machining processes, classification based on nature of energy employed in machining, selection of non-traditional machining processes, Specific advantages, limitations and applications of non-traditional machining processes.	**08 Hours / L2**
Module 2 **Ultrasonic Machining (USM):** Introduction, Equipment and material process, Effect of process parameters: Effect of amplitude and frequency, Effect of abrasive grain diameter, effect of slurry, tool & work material. Process characteristics: Material removal rate, tool wear, accuracy, surface finish, applications, advantages & limitations of USM. **Abrasive Jet Machining (AJM):** Introduction, Equipment and process of material removal, process variables: carrier gas, type of abrasive, work material, stand-off distance (SOD). Process characteristics-Material removal rate, Nozzle wear, accuracy & surface finish. Applications, advantages & limitations of AJM.	**08 Hours / L2**

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Module 3 **Electrochemical Machining (ECM):** Introduction, Principle of electro chemical machining, ECM equipment, elements of ECM operation, Chemistry of ECM. ECM Process characteristics: Material removal rate, accuracy, surface finish. Process parameters: Current density, Tool feed rate, Gap between tool & work piece, velocity of electrolyte flow, type of electrolyte, its concentration temperature, and choice of electrolytes. Applications of ECM. Electrochemical grinding and electrochemical honing process, advantages, disadvantages and application of ECG, ECH. **CHEMICAL MACHINING (CHM):** Elements of the process, Resists (maskants), Etchants. Types of chemical machining process-chemical blanking process, chemical milling process. Process characteristics of CHM: Material removal rate, accuracy, surface finish, advantages, limitations and applications of chemical machining process.	**08 Hours / L2**
Module 4 **ELECTRICAL DISCHARGE MACHINING (EDM):** Introduction, Classification of EDM, EDM principle, mechanism of metal removal. EDM equipment: Spark erosion generators (relaxation type), Electrode feed control system. Flushing types: pressure flushing, suction flushing, side flushing, pulsed flushing. EDM process parameters: Spark frequency, current & spark gap, surface finish, heat affected Zone. Advantages, limitations & applications of EDM. Electrical discharge grinding, Traveling wire EDM. **PLASMA ARC MACHINING (PAM):** Introduction, non-thermal generation of plasma, equipment mechanism of metal removal, Plasma torch, process parameters, process characteristics. Safety precautions, applications, advantages and limitations.	**08 Hours / L2**
Module 5 **LASER BEAM MACHINING (LBM):** Introduction, generation of LASER, Equipment and mechanism of metal removal, LBM parameters and characteristics, Applications, Advantages & limitations of LBM. **ELECTRON BEAM MACHINING (EBM):** Introduction, Principle, equipment and mechanism of metal removal, applications, advantages and limitations of EBM.	**08 Hours / L2**

COURSE OUTCOMES: Upon completion of this course, student will be able to:

CO824.1	Analyze advanced concepts of modern machining processes and their applications to innovate and enhance manufacturing techniques.
CO824.2	Evaluate non-traditional machining (NTM) processes utilizing mechanical energy to optimize manufacturing efficiency and precision.
CO824.3	Synthesize a comprehensive understanding of electrochemical and chemical machining processes to develop and optimize applications for complex material removal.
CO824.4	Assess the application of electrical discharge machining and plasma arc machining processes in modern manufacturing to solve specific machining challenges.
CO824.5	Evaluate the roles of laser beam and electron beam machining in non-traditional manufacturing processes to advance precision and functionality in complex production environments.

Textbooks:

1. Modern Machining Process by P.C Pandey and H S Shah McGraw Hill Education India Pvt. Ltd.
2. Production technology HMT McGraw Hill Education India Pvt. Ltd

Reference books:

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1. New Technology by Dr. Amitabha Bhattacharyya The Institute of Engineers (India).
2. Modern Machining Processes by Anand Pandey, Ane Books Pvt. Ltd., New Delhi, India.

E-Books / Web References

1. https://www.youtube.com/watch?v=-Nf8f6ky-B8
2. nptel.ac.in/courses/112104195/3
3. https://www.youtube.com/watch?v=cxU1zUOpGLk
4. nptel.ac.in/courses/112105126/40
5. nptel.ac.in/courses/112105126/39

MOOCs

1. https://onlinecourses.nptel.ac.in/noc22_me119/preview

Scheme of Examination: (Theory courses)

Semester End Examination (SEE):

SEE Question paper is to be set for 100 marks and the marks scored will be proportionately reduced to 50. There will be two full questions (with a maximum of four sub questions) from each module carrying 20 marks each. Students are required to answer any **five full questions** choosing at least **one full question from each module.**

Continuous Internal Evaluation (CIE):

Three Tests are to be conducted for 40 marks each. Average of three tests is taken. CIE is executed by way of one quiz / Alternate Assessment Tools (AATs), and average of three tests. One quiz is conducted and evaluated for 10 marks.

Some possible methods of assessment for assignments: Assignments/ Oral presentations / Group activity/Projects

Typical Evaluation pattern for regular courses is shown in Table 2.

Table 2: Distribution of weightage for CIE & SEE

	Component	Marks	Total Marks
CIE	CIE Test-1	**40**	**50**
	CIE Test-2	**40**	
	CIE Test-3	**40**	
	Quiz/AAT	**10**	
SEE	Semester End Examination	**50**	**50**
Grand Total			**100**

CO/PO Mapping															
CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO824.1	3	2	1	1		2	2				1	1			3
CO824.2	3	2	1	1		2	2				1	1			3
CO824.3	3	2	1	1		2	2				1	1			3
CO824.4	3	2	1	1		2	2				1	1			3
CO824.5	3	2	1	1		2	2				1	1			3
Average	**3**	**2**	**1**	**1**		**2**	**2**				**1**	**1**			**3**

Low - 1: Medium - 2: High - 3

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SEMESTER – VIII

Course: Project phase II

Course Code	21MED83	CIE Marks	50
Hours/Week (L: T: P)	0 : 0 : 2	SEE Marks	50
No. of Credits	12	Examination Hours	03

CIE for Project Phase - II:

1. **Single discipline:** The CIE marks awarded for the project work phase -2, shall be based on the evaluation of project work phase -2 Report, project presentation skill and question and answer session in the ratio 50:25:25.The marks awarded for the project report shall be the same for all the batch mates using Rubrics.

2. **Interdisciplinary:** Continuous Internal Evaluation shall be group wise at the college level with the participation of all guides of the college. Participation of external guide/s, if any, is desirable. The CIE marks awarded for the project work phase -2, shall be based on the evaluation of project work phase -2 Report, project presentation skill and question and answer session in the ratio 50:25:25.The marks awarded for the project report shall be the same for all the batch mates as per Rubrics covering all Program Outcomes.

SEE for Project Phase - II:

1. **Single discipline:** Contribution to the project and the performance of each group member shall be assessed individually in semester end examination (SEE) conducted at the department.
2. **Interdisciplinary:** Contribution to the project and the performance of each group member shall be assessed individually in semester end examination (SEE) conducted separately at the departments to which the student/s belong to.

Typical Evaluation pattern for regular courses is shown in Table 2.

Table 2: Distribution of weightage for CIE & SEE of Regular courses

	Component	Marks	Total Marks
CIE	Review-II	50	50
	Review-III	50	
SEE		50	50
Grand Total			100

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SEMESTER – VIII

Course: Technical Seminar

Course Code	21MED84	CIE Marks	100
Hours/Week (L: T: P)	1 : 0 : 0	SEE Marks	-
No. of Credits	1	Examination Hours	-

Technical Seminar:

All the students admitted to IV year of BE/B. Tech shall have to do power point presentation on any topic related to Mechanical Engineering during VIII Semester and make a report of the presented topic referring to journals in that area. The prescribed credit shall be included in VIII Semester and shall be considered for the award of bachelor's degree. Those who do not present the Technical Seminar shall be declared fail and shall have to complete during subsequent University examination after satisfying the Technical Seminar requirements.

CIE procedure for Seminar:

The CIE marks shall be awarded by a committee consisting of the Head of the concerned Department and two senior faculty members of the Department, one of whom shall be the Guide.

The CIE marks awarded for the Seminar shall be based on the evaluation of Seminar report, presentation skill and question and answer session in the ratio **50:25:25**.

Typical Evaluation pattern for regular courses is shown in Table below.

Distribution of weightage for CIE of Regular courses

	Component	Marks	Total Marks
CIE	Technical Seminar Presentation + Report	**100**	**100**

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SEMESTER – VIII

Course: INTERNSHIP

Course Code	21MED85	CIE Marks	50
Hours/Week (L: T: P)	0 : 0 : 0	SEE Marks	50
No. of Credits	2	Examination Hours	03

Internship:
All the students admitted to III year of BE/B. Tech shall have to undergo mandatory internship of 4 weeks during the vacation of VI and VII semesters and /or VII and VIII semesters. Internship examination shall be conducted during VIII semester and the prescribed credit shall be included in VIII semester. Internship shall be considered as a head of passing and shall be considered for the award of degree. Those, who do not take-up/complete the internship shall be declared fail and shall have to complete during subsequent University examination after satisfying the internship requirements.

CIE procedure for Internship:
The CIE marks shall be awarded by a committee consisting of the Head of the concerned Department and two senior faculty members of the Department, one of whom shall be the Guide.
The CIE marks awarded for the Internship shall be based on the evaluation of Internship report, presentation skill and question and answer session in the ratio **50:25:25**.

Typical Evaluation pattern for regular courses is shown in Table.

Table: Distribution of weightage for CIE of Regular courses

	Component	Marks	Total Marks
CIE	Review	**50**	**50**
SEE	Review	**50**	**50**
		Grand Total	**100**

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