MALNAD COLLEGE OF ENGINEERING, HASSAN

(An Autonomous Institution Affiliated to VTU, Belagavi)

Autonomous Programmes

BACHELOR of ENGINEERING

DEPARTMENT OF MECHANICAL ENGINEERING

SYLLABUS

V AND VI SEMESTERS

(THIRD YEAR)

Academic Year 2023-24

Department of Mechanical Engineering

Vision of The Department:

To emerge as department of high repute in Mechanical Engineering and allied fields through effective teaching, learning process and research activities, operating with a sense of professional and social responsibility.

Mission of The Department:

1. Empower students to scale high in their professional career through upskilling.
2. Effective association with higher institutes of learning, industry and research laboratories with emphasis on multi-disciplinary approach.
3. Encourage students to participate in sustainable projects.
4. Inculcate professional and ethical norms in all activities.

Program Educational Objectives:

PEO 1: Graduates will be able to apply engineering principles to develop products, processes or knowledge to solve mechanical and associated engineering problems for successful careers in mechanical engineering/higher education/research.

PEO 2: Graduates will acquire leadership qualities with strong communication skills along with professional and ethical values.

PEO 3: Graduates will be able to become entrepreneur / innovators to design and develop manufacturing systems and services to address social, technical and business challenges.

PEO 4: Graduates will be lifelong learners.

PROGRAM OUTCOMES [POs]:

Mechanical Engineering students shall be able to,

PO1:	**Engineering knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2:	**Problem analysis**: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3:	**Design/development of solutions**: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO4:	**Conduct investigations of complex problems**: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO5:	**Modern tool usage**: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
PO6:	**The engineer and society**: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO7:	**Environment and sustainability**: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO8:	**Ethics**: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO9:	**Individual and teamwork**: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO10:	**Communication**: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
PO11:	**Project management and finance**: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
PO12:	**Life-long learning**: Recognize the need for and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

PROGRAM SPECIFIC OUTCOMES [PSOs]

PSO1: Apply the knowledge of design engineering skills to manufacture an engineering mechanical system.

PSO2: Model, simulate, analyze and optimize mechanical systems / processes through application of software.

Scheme of Evaluation (Theory Courses)

	Portions for CIE	Mode of Evaluation	Weightage in Marks
CIE - 1	Syllabus to be decided by the course coordinators such that all the COs shall be covered.	Descriptive Test	**10**
CIE - 2		Descriptive Test	**10**
CIE - 3		Descriptive Test	**10**
Activity	Minimum of two activities to be conducted	Assignment / Case study/Practical/ Working model /Quiz	**20**
		Total	**50**

Examination		**Maximum marks**	**Minimum marks to be scored**	**Minimum Average marks to qualify**
CIE	**Tests**	**30**	**12 (> = 40%)**	**40 (> = 40%)**
	Activity	**20**	**08 (> = 40%)**	
SEE		**50**	**17.5 (> = 35%)**	

Scheme of Evaluation (Laboratory Courses)

Evaluation Type	**Evaluation modules**	**Marks**
Continuous internal Evaluation (CIE) in every lab session by the Course coordinator	Conduction of experiments	10
	Observation and tabulation of results	10
	Record writing	20
	Viva voce/Quiz	10
CIE		**50**
SEE		**50**

Note: The marks distribution to be made based on the rubrics for a particular laboratory course.

Scheme & Syllabus for III Year
B.E. – Mechanical Engineering
Academic Year 2023-24

V Semester B.E. Mechanical Engineering							
Course Type	**Course Code**	**Course Title**	**Credits**			**Total Credits**	**Total Contact Hours**
			L	T	P		
PCC	21ME501	Heat Transfer	2	1	0	**3.0**	4
PCC	21ME502	Design of Machine Elements	3	1	0	**4.0**	5
ESC	21ME503	Microprocessors and Mechatronics	3	0	0	**3.0**	3
IPCC	21ME504	Manufacturing Science – II	2	0	1	**3.0**	4
PCC	21ME505	Geometric Dimensioning and Tolerance	3	0	0	**3.0**	3
AEC	21ME506	Production Drawing	0	0	2	**1.0**	4
PCCL	21ME507	Fluid Mechanics and Fluid Machines Lab	0	0	1	**1.0**	2
PI	21INT2	Summer Internship – II	0	0	1	**3.0**	
UHV	21SCR	Social Connect and Responsibility	0	1	0	**1.0**	2
HSMC	21CIP	Constitution of India and Professional Ethics (Mandatory course)	0	1 (A)	0	**AUDIT**	2
Total			**13**	**03**	**06**	**21.0**	**33**

HEAT TRANSFER

21ME501 **LTPC: 2-1-0-3**

Exam Hours: 3 **Hours / Week: 04**

SEE: 50 Marks **Total hours: 40**

Course objective:

To provide students with the fundamentals and mechanisms of heat transfer, allowing them to develop methodologies for problem solving in the real world.

Course Outcomes (COs){with mapping shown against the Program Outcomes (POs)}

Upon completion of the course, students shall be able to:

Cos	Statement	Pos
1.	apply basic laws of heat transfer in steady and unsteady state thermal analysis of engineering systems.	1, 2,3
2.	analyze the heat transfer mechanism through natural and forced convection inside ducts & exterior surfaces.	2,3,7
3.	carry out preliminary heat exchanger design and explain the concepts of boiling & condensation, as well as the principles of radiation heat transfer.	2,3,7

COURSE CONTENTS:

Module –I	**10 Hrs**.
Introduction: Basic laws governing modes of heat transfer, Conduction-Basic Equations: Derivation of general form heat conduction equation in three-dimension rectangular coordinates. Types of boundary conditions, Thermal resistance in series and in parallel. **One dimensional steady state conduction:** Steady state conduction in a slab, cylinder and sphere with and without heat generation, Composite wall and overall heat transfer coefficient (No derivation), critical thickness of insulation, Heat transfer in extended surfaces of uniform cross-section without heat generation, Long fin, short fin with insulated tip and without insulated tip. Fin efficiency and effectiveness. Numerical problems. **Self -Learning Element:** Modes of heat transfer, Expression for heat transfer rate, temperature distribution and overall heat transfer coefficient for composite plane wall, cylinder and sphere.	
Module – II	**10 Hrs**.
One-Dimensional Transient Conduction: Conduction in solids with negligible internal temperature gradient (Lumped system analysis), Use of Transient temperature charts (Heisler's charts) for transient conduction in slab, long cylinder and sphere; Numerical Problems.**Free or Natural Convection:** Application of dimensional analysis for free convection- physical significance of Grashoff number; use of correlations of free convection in vertical, horizontal and inclined flat plates, vertical and horizontal cylinders and spheres, Numerical problems**. Self - Learning Element:** Biot number and Fourier number and its significance, Dimensionless number, advantages and disadvantages of dimensionless number.	

Module – III	
Forced Convection: Applications of dimensional analysis for forced convection. Physical significance of Reynolds, Prandtl, Nusselt and Stanton numbers. Use of various correlations for hydro dynamically and thermally developed flows inside a duct, use of correlations for flow over a flat plate, over a cylinder and sphere. Numerical problems. **Heat Exchangers:** Classification of heat exchangers; overall heat transfer coefficient, fouling and fouling factor; LMTD method of analysis of heat exchangers. Numerical problems. **Self -Learning Element:** Boundary Layer Theory, Velocity and Thermal Boundary Layers, Definition of heat exchangers, Applications of heat exchanger.	**10 Hrs**.
Module – IV	
Condensation And Boiling: Types of condensation (discussion only), use of correlations for condensation on vertical flat surfaces, horizontal tube and horizontal tube banks; Reynolds number for condensate flow; regimes of pool boiling, pool boiling correlations. Numerical problems. **Radiation Heat Transfer:** Radiation laws, Thermal radiation; Radiation heat exchange between two parallel infinite black surfaces and infinite gray surfaces; effect of radiation shield; intensity of radiation and solid angle; Numerical problems **Self -Learning Element:** Introduction to boiling, pool boiling, Bubble Growth Mechanisms**,** Fundamental principles - Gray, White, Opaque, Transparent and Black bodies, Spectral emissive power**.**	**10 Hrs**.

TEXT BOOKS:

1. Principals of heat transfer,FrankKreith, Raj M. Manglik, Mark S. Bohn, Seventh Edition, Cengage learning, 2011.
2. YunusCengelandAfshinGhajar, Heat and Mass Transfer: Fundamentals and Applications, McGraw Hill Education (India) Private Limited;5th Edition,2015.

REFERENCE BOOKS:

1. Fundamentals of Heat and Mass Transfer, Incropera, F. P. and De Witt, D. P., 5th Edition, John Wiley and Sons, New York, 2006.
2. P.K.Nag, Heat & Mass Transfer, TMH, 2008. ISBN:0-07-047337-4
3. S.P.Sukhatme, Heat transfers, 4th edition. ISBN:8173715440
4. R.K.Rajputh, Heat & Mass Transfer, S.Chand& Company Ltd, 3rd Edition, 2006. ISBN :81-219-1777-8

HEAT TRANSFER DATA HAND BOOK:

1. Heat and Mass Transfer Data Book (S.I. Unit) by V.M. Domkundwar, Anand V. Domkundwar ISBN: 670000000039, Publisher: DhanpatRai&Co.Year of publishing: 2014.

E-BOOKS/WEB REFERENCES:

1. A Text book of Heat Transfer, John H Lienhard, 4th Edition,
2. NPTEL Heat Transfer course for Mechanical Engineering, http://nptel.ac.in/courses/112101097/
3. Heat Transfer, Chris Long & Naser Sayma, Bookboon.com

MOOCs:

1. Fluid flow, Heat and Mass Transfer- http://ocw.tudelft.nl/courses/applied-earth-sciences/fluid-flow-heat-mass-transfer/course
2. Heat transfer course- https://legacy.saylor.org/me204/Intro/

DESIGN OF MACHINE ELEMENTS

21ME502 **LTPC: 3-1-0-4**

Exam Hours:**3** Hours / Week :**05**

SEE: **50 Marks** **Total hours: 52**

Course objectives:

To design simple machine elements subjected to static and dynamic loads using the concepts of stress analysis and theories of failure.

Upon completion of the course, students shall be able to:

COs	Statement	Pos	PSOs
1.	apply basic stress-strain analysis and failure theories to design machine elements subjected to Static and Dynamic loads	1,2,3,12	1
2.	design of mechanical elements using standard practice	2,3,5,9,12	2

COURSE CONTENTS:

Module – 1	
Introduction: Mechanical Engineering Design, Phases of design Process, Design Considerations, Engineering Materials and their mechanical properties, Review of definitions - normal, shear, Biaxial and Triaxial Stresses, Principal Stresses. Design for Static Strength: Theories of failure – Maximum Normal stress Theory, Maximum Shear stress Theory, Distortion Energy Theory; Brittle and ductile failure. Stress concentration, Determination of Stress concentration factor. **Design for dynamic loads**: Impact strength: Introduction, Impact stress due to Axial, Bending and Torsional loads, Impact factor.	**13 Hrs**
Module -2	
Fatigue loads: Introduction, Fatigue failure, Definition of Low Cycle Fatigue and High Cycle Fatigue, S-N diagram, Endurance Limit, Correction factors for Load, Size and surface finish, Fatigue Stress concentration factor, Notch sensitivity, Factors affecting Fatigue; Goodman and Soder-berg relationships. Problems on members subjected to fatigue due to Axial, Bending, Torsion, and combined loads. **Curved Beams**: Winkler - Bach equation, Stresses in curved beams of standard cross sections used in crane hook, Punching presses and clamps.	**13 Hrs**
Module – 3	
Design of Gears- Spur and Helical Gears: Definitions, stresses in gear tooth, Lewis equation and form factor, design for strength, dynamic and wear loads. Bevel Gears: Definitions, formative number of teeth, stresses in gear tooth, design for strength, dynamic and wear loads**Design of Worm Gears:** Definitions, design based on strength, dynamic, wear loads and efficiency of worm gear drives.	**13 Hrs**
Module – 4	
Threaded Fasteners: Stresses in Threaded Fasteners. Effect of Initial Tension, Design of Threaded Fasteners under Static, Dynamic and Impact loads. Eccentrically loaded bolted joints, **Riveted Joints**: Failures of Riveted joints, Design of Boiler joints as per IBR, Eccentrically loaded riveted joints, **Welded Joints** – Types, Strength of Butt and Fillet welds, Eccentrically loaded welded joints.	**13 Hrs**

Self study component

- Design of components subjected to eccentric loads
- Cumulative fatigue damage, Miner's rule. (https://www.sciencedirect.com/science/article/abs/pii/S0142112397000819)
- Design of splined shafts.
- Keys: Types of Keys, Selection of square keys
- Design of Knuckle Joint, cotter joint, Rigid and Flexible couplings: Flange Coupling, Bush and pin type Coupling
- Influence of Heat Affected Zone (HAZ) in welded joint
- Differential and Compound screws, Recirculating ball screw. https://freevideolectures.com/course/2363/design-of-machine-elements-i

TEXT BOOK:

1. Maleev&Hartman's, *Machine Design in SI units*, 6th Edition, C B S Publications, Delhi, 2015. ISBN:9788123926322

REFERENCE BOOKS:

1. M.F. Spotts, T.E. Shoup, L.E. Hornberger, S.R.Jayaram&C.V.Venkatesh, *Design of Machine Elements,* Pearson Education, 8th Edition, 2006. ISBN 9788177584219
2. Joseph Edward Shigley, *Mechanical Engineering Design*, Mc. Graw Hill, 8th Edition, 2008. ISBN:9780073529288.
3. V. B. Bhandari, *Design of Machine Elements,* TMH, 3rd Edition, 2007. ISBN:9780070681748

DESIGN DATA HAND BOOKS:

1. K. Mahadevan and Balaveera Reddy, Design *Data Hand Book,* C B S Publications, Delhi. 4th edition, 2013. ISBN: 9788123923154.

MICROPROCESSOR AND MECHATRONICS

21ME503 **LTPC: 3-0-0-3**
Exam Hours: 3 **Hours / Week: 03**
SEE: 50 Marks **Total hours: 40**

Course Objectives: To impart the knowledge of Microprocessors, Microcontrollers, PLCs' and its role in Mechatronic systems. To introduce the students, the fundamentals of interdisciplinary engineering components and their integration in Mechatronic systems design approach.

Course Outcomes (COs) {with mapping shown against the **Program Outcomes (POs)}**

Upon completion of the course, students shall be able to:

#	Course Outcomes	Mapping to POs	Mapping to PSOs
1	interpret the basicprinciples of Microprocessor, Microcontroller and PLC controlled Mechatronics system	1, 2	-
2	Applythe concepts of automatic control system for Engineering applications using digital Controls	1, 3	2
3	Designdigitally controlled Mechatronics system forindustrial process automation	3, 5	2

Course Contents:

Module – 1	10 Hrs
Introduction to Microprocessor and Microcontrollers: Introduction, General form of Microprocessor system, General internal Architecture of a Microprocessor, Memory structure, input/output operations,General Architecture of Microcontroller, Microchip microcontrollers, Basic features of Microcontroller, Applications of Microcontrollers (Temperature measurement system and Domestic washing machine) Microcontroller Programming method.**Mechatronics:**Role of Various Engineering disciplines in Mechatronics, Mechatronics design elements, Scope and Applications of Mechatronics.	
Module – 2	**10 Hrs**
Design of Mechatronics Systems: Control system, Microprocessor based controllers. Sensors, actuators:Encoders.D. C. Motors, A. C. Motors, Stepper motors,Analog to Digital Converter (ADC) and Digital to Analog Converter (DAC).**Embedded systems:** Embedded Programming, Mechatronics Design Solutionsfor: Timed Switch, Windscreen Wiper motion, Automatic Camera System, Pick and place robot, Engine management system.	
Module – 3	**10 Hrs**
Introduction To PLC: Definition and history of the PLC,PLC advantages, Overall PLC system, Modular Construction of a PLC, PLC I/O Components, Digital Input Modules, Digital Output Modules, Communication Modules, Central Processing Unit and programmers/monitors, The PLC as a computer, Networking PLCs: Levels of Industrial control, Types of Networking, Network communications, PLC and Internet, Cell control by PLC Networks.	
Module – 4	**10 Hrs**
PLC Programming: Introduction to Programming of PLCs, General PLC Programming procedures, Programming on/off inputs, Digital logicgates for Ladder logic programs:(OR, AND, NOT, NAND, NOR gates), Creating Ladder diagrams from process control descriptions, PLC Functions: Register basics, Timer Functions, Counter functions, Simple Ladder Logic Programs using above PLC functional elements for automatic industrial process controls.	

Self-learning components:

- Sensor Networks in Mechatronics
- Mechatronics in Biomedical Engineering
- Autonomous Robots using Mechatronics
- Mechatronics in Agriculture: Opportunities and Challenges

PLC Programming with Wireless Connectivity

Activity:

1. PLC Programming using Ladder logics.
2. PLC kit hardware interfacing for simple industrial controls.

Microcontroller based systems.

TEXT BOOKS:

1) William Bolton, Mechatronics, Sixth Edition, Pearson, ISBN-9788131732533
2) John W. Webb and Ronald A. Reis, Programmable Logic Controllers: Principles and Applications, Fifth Edition, Pearson, 2015, ISBN-13 978-9332555129

REFERENCE BOOKS:

1) Aditya P. Mathur, "Introduction to Microprocessors", THM 3rd edition, 2000, ISBN_0-07-460222-5

2) Stamatios Manesis & George Nikolakopoulos, Introduction to Industrial Automation, CRC Press, 2018,
ISBN: 978-1-4987-0540-0

3) Hugh Jack, Automating Manufacturing Systems with PLCs, Publisher: Lulu.com (September 12, 2010);
eBook (Creative Commons Licensed)

4) M D Singh and J G Joshi, Mechatronics, Prentice-Hall-India, ISBN-81-203-2986

MANUFACTURING SCIENCE – II (Lab Integrated)

21ME504 **LTPC: 2-0-1-3**

Exam Hours: 3 **Hours / Week: 02+02**

SEE: 50 Marks **Total hours: 26+26**

Course objectives:

To impart the knowledge on metal cutting principles and the principles of non-traditional machining processes.

Course Outcomes (COs) {with mapping shown against the **Program Outcomes (POs)**}
Upon completion of the course, students shall be able to:

COs	Statement	POs	PSOs
1.	explain the principles of machining, mechanisms involved in chip formation, and mechanics of metal cutting	1, 2, 7	-
2.	grasp the knowledge of machining temperature, finishing processes, tool wear, tool life and cutting fluids	1, 2, 7	-
3.	explain the principle, process parameters and applications of various advanced and hybrid machining processes	1, 2	-

COURSE CONTENTS:

Module – I	**7 Hrs.**
Introduction to Machining Processes: Subtractive manufacturing processes and classifications.**Principles of machining**- Introduction, orthogonal and oblique machining, basic tool angles of single point cutting tool, mechanism of chip formation, types of chips. **Mechanics of metal cutting:** Cutting ratio, shear angle and its significance, Merchant's circle diagram, and Ernst-Merchant theory on orthogonal machining. Numerical examples on Merchant's circle diagram.	
Module – II	
Machining temperature and its control: Heat sources in machining, Cutting Fluids: Characteristics of cutting fluids, types, and applying methods of cutting fluids. **Tool wear and tool life:** Modes of tool failure, the effect of cutting parameters on tool life, tool life criteria, Taylor's tool life equation, and problems on tool life evaluation. **Finishing Process:** Importance of surface finishing processes, Grinding, Honing, Polishing, and Lapping.	**6 Hrs.**
Module – III	
Advanced Machining Process: Importance and classification of the advanced machining process. **Process principal, process parameters, and application of** Abrasive Jet Machining (AJW), Water Jet Machining (WJM),Ultrasonic Machining (USM), Wire Electrical Discharge Machining (WEDM), Electro Chemical Machining (ECM), ElectronBeam Machining (EBM), and Plasma Arc Machining (PAM).	**6 Hrs.**
Module – IV	
Hybrid Machining Process: Importance of hybrid machining process, Process principal, process parameters, and application of Electrochemical Discharge Machining (ECDM), Ultrasonic Assisted Electric Discharge Machining (UAEDM), Electrochemical Discharge Grinding (EDG), Powder Assisted Electric Discharge Machining (PAEDM). **Jigs and Fixtures:** Importance of jigs and fixtures, the difference between jigs and fixtures,and types of jigs and fixtures.	**6 Hrs.**

Lab Component

- Facing and countersinking, turning, taper turning, thread cutting, grooving, chamfering, and boring operations on the lathe.
- Machining rectangular, triangular &dovetail slots on the shaping machine. Face milling, milling keyways using end mill cutters, and gear cutting.

TEXTBOOK

1. A.B. Chattopadhyay, "Machining and Machine Tools"' Wiley India Pvt. Ltd. 2nd Edition, 2012. ISBN: 978-81-265-3098-4.
2. Amitabha Ghosh and Ashok Kumar Mallik,"Manufacturing Science", Affiliated East-West Press. 2nd Edition, 2010. ISBN: 9788176710633, 9788176710633.

REFERENCE

1. SeropeKalpakjian,"Manufacturing Processes for Engineering Materials", Pearson. 6th Edition, 2021. ISBN-13: 9780137503520
2. Pandey and Shan, Modern machining process**,** TATA McGraw Hill 2000. ISBN 0070965536.

GEOMETRIC DIMENSIONING AND TOLERANCING

21ME505 **LTPC: 3-0-0-3**

Exam Hours: 3 **Hours / Week: 02**

SEE: 50 Marks **Total hours: 40**

Course Objective: To teach the students concepts and interpretation of Geometric Dimensioning and Tolerancing of a component that goes into assembly from the point of view of Design, manufacture and Assembly.

Upon completion of the course, students shall be able to:

#	Course Outcomes	Mapping to POs
1.	Comprehend the mutual dependence of design and manufacture in the production of cost effective quality products	3
2.	recognize various symbols used to specify tolerances on component drawings and understand the functional significance of a particular feature on a component	4
3.	Interpret and/or specify tolerance for a specific fit between mating components in an assembly	4
4.	Identify the most suitable inspection method/technique for cost effective quality control	11

Course contents:

Module – 1	
Introduction to Geometrical Tolerancing: Need for GD&T, Size general principles, Definitions of size, Groups of sizes and dimensions. Classification and symbols of Geometric Tolerancing. **Tolerances of form** - General concepts, Straightness, Roundness, Flatness, Cylindricity, Line and surface profile, Rules for form Tolerancing.	**10 Hrs.**
Module – 2	
Datums: Datums, datum features and simulated datum features, Establishing datums, Datum targets, Datum systems - Three-Plane datum-system, Groups of feature nominated as datums.**Tolerances of Orientation:** Parallelism Perpendicularity and Angularity tolerances with typical examples	**10 Hrs.**
Module – 3	
Tolerance of location: Position, Concentricity & Coaxiality and Symmetry tolerances, Tolerances of line or surface with or without datum - Profile any line, Profile any surface.**Tolerances of runout:** Circular run-out, Circular run-out in the radial direction, Circular run-out in the axial and in any direction, total runout. **Material Conditions:** Maximum and least material condition, Shift Tolerance, Principle of independency, Maximum material condition, Maximum material virtual limit, Least material requirement, Reciprocity requirement.	**10 Hrs.**
Module – 4	
Taylor's Principle of design of gauges, Taylor's Envelop Principle, Go and No Go gauges for size, Terms and Definitions for Individual Features of Size, Actual Size Definitions, Relationship of individual Features, Perfect Orientation between Features.Projected tolerance zone, Free state Tolerancing. Introduction to stack up analysis.	**10 Hrs.**

SELF STUDY COMPONENT

- To undergo survey on various applications of GD&T symbols in production drawings of real world applications and prepare a report on it.

Group activity on preparation of GD&T models for different types of tolerances and prepare a report on it.

TEXT BOOK

Geometrical Product Specifications – Course for Technical Universities by Z. Humienny et al, Warsaw University Press 2001

REFERENCE BOOKS

1. Geometric Dimensioning and Tolerancing, for Mechanical design by Gene R. Cogorno, McGraw Hill, 2006

Geometric Dimensioning and Tolerancing – James D. Meadows, Marcel Dekker Inc., Special Indian Edition, 1995

COURSE ARTICULATION MATRIX

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	-	-	3	-	-	-	-	-	-	-	-	-	-	-
CO2	-	-	-	3	-	-	-	-	-	-	-	-	-	-
CO3	-	-	-	3	-	-	-	-	-	-	-	-	-	-
CO4	-	-	-	-	-	-	-	-	-	-	3	-	-	-

PRODUCTION DRAWING

21ME506 **LTPC: 0-0-2-1**

Exam Hours: 3 **Hours / Week: 02**

SEE: 50 Marks **Total hours: 26**

Objective: The student shall be able to prepare the Component Drawings and Process Sheets, an authorized document of simple Machine Component Assemblies that facilitate their manufacture on the shop floor.

Prerequisite: 21ME405

Course Outcomes (COs) {with mapping shown against the **Program Outcomes (POs)**}

Upon completion of the course, students shall be able to:

#	Course Outcomes	Mapping to POs	Mapping to PSOs
1.	realize the need for dimensional, geometrical tolerance and the functional relationship between different components in design and manufacturing of engineering components as per ISO/BIS standards	1, 3, 5, 8,10, 12	1, 2
2.	prepare production drawings by applying GD &T concepts on to the production drawing of individual components as per ISO/BIS standards and/or process sheets for manufacture of components	5, 8, 10, 12	1, 2

Part – A

1.	Selection of Limits, Fits and Tolerances for different functional requirements in assemblies.Exercises on interpretation of Geometrical tolerances and Material conditions.Surface Roughness – Symbols and interpretation, Roughness values achievable in different manufacturing processes.
2.	Process sheets - Exercises on Process sheets

Part – B: Production drawing with Process Sheets to be prepared for the following assemblies

3.	Tappet in guide,
4.	Bush bearing.
5.	Valve guide and Valve seat
6.	Footstep bearing
7.	Protected flange coupling
8.	Piston
9.	Square tool post
10.	Lathe tail stock
11.	**Group Activity I -** Disassembling any simple machine assemblies, measuring component dimensions, preparing production drawings and preparing process sheets
12.	**Group Activity II –**Prepare Production Drawing for the components of activity I using any CAD tool
Scheme of Evaluation	
CIE – 50 Marks [Home Assignments + Class work and assignments + Group Activity – 30 Marks + CIE test – 20 Marks] **SEE-50 Marks**	

The question paper shall contain two parts and there shall be **two**questions from **Part – A for total 20 marks** and two questions from **Part – B** for a total of **30 Marks.** i. **Two** Questions each of **10 marks** for a total marks of **20** shall be set **from 1 and 2.** ii. **Two**Questionseach of **15 marks**for total marks of **30** shall be set **from 3 to 10**. **Note:** i)The duration of examination (SEE) – 3 hrs for 50 marks. ii) Part A questions to be answered in Answer booklet only.
Text Book – Production Drawing – K.L.Narayana, P. Kannaiah, K. Venkatareddy , New Age International, Third Edition, 2014.

COURSE ARTICULATION MATRIX

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	-	3	-	3	-	-	2	-	2	-	2	-	3
CO2	-	-	3	-	3	-	-	2	-	3	-	2	3	3

FLUID MECHANICS AND MACHINERY LABORATORY

21ME507 **LTPC: 0-0-1-2**
Exam Hours: 3 **Hours / Week: 2**
SEE: 50 Marks **Total Hours: 14**

Prerequisites: Fluid Mechanics and Fluid Machines

Course objective:
To provide students with the necessary skills to conduct experiments, collect data, perform analysis and interpret results to draw valid conclusions through standard test procedures to calibrate the fluid flow measuring devices and to evaluate performance of hydraulic machines.
Course Outcomes (COs){with mapping shown against the Program Outcomes (POs)}
Upon completion of the course, students shall be able to:

COs	Statement	Pos
1	evaluate the losses through the pipes and the use of flow measuring devices.	1, 2
2	analyze the impulse-momentum principle to evaluate the hydrodynamic force exerted on a body by impact of jet.	1,2
3	investigate the performance parameters of hydraulic turbines and pumps.	2,3,9

COURSE CONTENTS:

1. Determination of coefficient of friction of flow in a pipe.
2. Determination of minor losses in flow through pipes.
3. Experiments on flow measuring devices
    a) Orifice plate
    b) Venturi-meter
4. Flow through notches
5. Impact of jets on vanes
6. Performance tests on Turbines
    a) Pelton Wheel
    b) Francis Turbine
    c) Kaplan turbine
7. Performance tests on pumps
    a) Centrifugal pump
    b) Reciprocating Pump.

SEE Scheme:

1.	Individual Experiment (1 to 5) - one question	15 Marks
2.	Group Experiment (6 or 7) - one question	25 Marks
3.	Viva Voce	10 Marks
	Total:	50 Marks

SOCIAL CONNECT & RESPONSIBILITIES

22SCR56 **LTPC: 0-0-2-1**
Exam Hours: 3 **Hours / Week: 2**
SEE: 50 Marks **Total Hours: 14**

Objective: Enable the student to do a deep drive into societal challenges being addressed by NGO(s), social enterprises & the government and build solutions to alleviate these complex social problems through immersion, design & technology
Course Outcomes (COs) {with mapping shown against the **Program Outcomes (POs)**}

Upon completion of the course, students shall be able to:

	Course Outcomes	Mapping to POs	Mapping to PSOs
1.	Explain the social responsibility	6	-
2.	Practice sustainability and creativity	9	-
3.	Showcase planning and organizational skills	9, 10	-

Course contents:

Module – 1	04 Hrs.
Plantation and adoption of a tree: Plantation of a tree that will be adopted for four years by a group of B.Tech. students. They will also make an excerpt either as a documentary or a photoblog describing the plant's origin, its usage in daily life, and its appearance in folklore and literature.	
Module – 2	**03 Hrs.**
Heritage walks and crafts corner: Heritage tour, knowing the history and culture of the city, connecting to people around through their history, knowing the city and its craftsman, photoblog and documentary on evolution and practice of various craft forms.	
Module – 3	**03 Hrs.**
Organic farming and waste management: usefulness of organic farming, wet waste management in neighboring villages, and implementation in the campus.	
Module – 4	**04 Hrs.**
Water Conservation: knowing the present practices in the surrounding villages and implementation in the campus, documentary or photo blog presenting the current practices. **Food Walk:** City's culinary practices, food lore, and indigenous materials of the region used in cooking.	
A total of 14hrs engagement per semester is required for the 5th semester of the B.E. / B.Tech. program. The students will be divided into 10 groups of 35 each. Each group will be handled by two faculty mentors. Faculty mentors will design the activities (particularly Jamming sessions open mic, and poetry) Faculty mentors have to design the evaluation system.	
Guideline for Assessment Process: Continuous Internal Evaluation (CIE) After completion of, the social connect, the student shall prepare, with daily diary as reference, a comprehensive report in consultation with the mentor/s to indicate what he has observed and learned in the social connect period. The report should be signed by the mentor. The report shall be evaluated on the basis of the following criteria and/or other relevant criteria pertaining to the activity completed. Marks allotted for the diary are out of 50. Planning and scheduling the social connect Information/Data collected during the social connect Analysis of the information/data and report writing	

VI Semester B.E. Mechanical Engineering							
Course Type	**Course Code**	**Course Title**	**Credits**			**Total Credits**	**Total Contact Hours**
			L	T	P		
PCC	21ME601	Mechanical Vibrations	2	1	0	**3.0**	4
IPCC	21ME602	Principles of CAD/CAM	2	0	1	**3.0**	4
IPCC	21ME603	Fluid Power Systems	2	0	1	**3.0**	4
PEC	21ME64X	Program Elective – 1	3	0	0	**3.0**	3
PEC	21ME65X	Program Elective – 2	3	0	0	**3.0**	3
OEC	21OEXXX	Open Elective -1	3	0	0	**3.0**	3
PCCL	21ME606	Heat TransferLaboratory	0	0	1	**1.0**	2
MP	21ME607	Mini Project	Two contact hours /week for interaction between the faculty and students.			**2.0**	4
HSMC	21EVS	Environmental Studies (Mandatory course)	0	0	0	**AUDIT**	2
OEC	21SWY	SWAYAM (NPTEL only)	0	0	0	**AUDIT**	2
AEC	21ASK	Analytical Ability and Soft Skills	0	1	0	**1.0**	2
Total			**17**	**02**	**03**	**22.0**	**31**

Program Elective – 1			**Program Elective – 2**	
21ME 641	Management & Entrepreneurship development		21ME 651	Quality Control and Management
21ME 642	Additive Manufacturing		21ME 652	Industrial Automation
21ME 643	Design of Experiments		21ME 653	Fundamentals of Tribology
21ME 644	Automotive Engineering		21ME 654	Micro-Electromechanical System (MEMS)
21ME 645	Project Management		21ME 655	Electric Vehicle Technology

Open Electives –1	
21OEME 61	Principles of Manufacturing
21OEME 62	Industrial Engineering and Ergonomics
21OEME 63	Project Management
21OEME 64	Occupational Health and Safety Engineering

MECHANICAL VIBRATIONS

21ME601 **LTPC: 2-1-0-3**

Exam Hours: 3 **Hours / Week: 04**

SEE: 50 Marks **Total hours: 40**

Course objectives: To provide basic knowledge on principles of vibrations so as to analyses, model and build mechanical systems.

Course Outcomes (COs) {with mapping shown against the **Program Outcomes (POs)**}

Upon completion of the course, students shall be able to:

#	Course Outcomes	Mapping to POs	Mapping to PSOs
1.	analyze undamped and damped free vibration for single degree freedom systems	2, 5	-
2.	analyze forced vibration for single degree of freedom systems	2	-
3.	design mechanical systems to achieve vibration isolation and measurement of vibration	2	-
4.	analyze free & forced vibration for two and multi degree of freedom systems	2, 3	-

Course Contents:

Module–1	**12 Hrs.**
Introduction: Types of Vibrations, Simple Harmonic Motion (S.H.M), and principle of super position applied to Simple Harmonic Motion, Beats, Undamped Free Vibrations: Single degree of freedom systems, Undamped free vibrations natural frequency of free vibration, stiffness of spring elements, effect of mass of spring, Compound Pendulum. **Damped Free Vibrations:** Single degree freedom systems, different types of damping, concept of critical damping and its importance, study of response of viscous damped systems for cases of under damping, critical and over damping, Logarithmic decrement	
Module –2	**08Hrs.**
Forced Vibrations: degree freedom systems, steady state solution with viscous damping due to harmonic force. Solution by Complex algebra, reciprocating and rotating unbalance, vibration isolation-transmissibility ratio, due to harmonic excitation and support motion.	
Module –3	**10 Hrs.**
Vibration Measuring Instruments & Whirling of Shafts: Vibrometer and accelerometer. Whirling of shafts with and without air damping, discussion of speeds above and below critical speeds. **Systems with Two Degrees of Freedom:** Introduction, principal modes and normal modes of vibration, co-ordinate coupling, generalized and principal co-ordinates, free vibration in terms of initial conditions.	
Module –4	**10 Hrs.**
Numerical Methods for Multi Degree Freedom Systems: Introduction, Influence coefficients, Maxwell reciprocal theorem, Dunkerley's equation. Orthogonality of principal modes, method of matrix iteration - Method of determination of all the natural frequencies using sweeping matrix and orthogonality principle. Holzer's method, Stodolamethod.	

Self-Study Component

1. Harmonic Analysis - Fourier's Series. Vibration Analysis:https://youtu.be/Vj1xmze3GlE. Vibration Diagnostics for beginners: https://youtu.be/4fDqII7ut6Y
2. Applications of Two Degrees of Freedom Systems like vehicle suspension, dynamic vibration absorber, Dynamics of reciprocating Engines
3. Mechanical Vibration - Virtual Labs, http://mdmv-nitk.vlabs.ac.in/#.

TEXT BOOKS:

1. S.S. Rao, *Mechanical Vibrations***,** Pearson Education Inc, 6th Edition, 2017. ISBN-9780134361307.

REFERENCE BOOKS:

1. Leonanrd Meirovitch, *Elements of Vibrations Analysis,*MH, Special Indian edition, 2007, ISBN-81-7700-047-0.
2. S.Graham Kelly, *Mechanical Vibrations*, Schaum's outline series, TMH, Special Indian Edition, 2007, ISBN-14-09780070616790.

PRINCIPLES OF CAD/CAM

21ME602 **LTPC: 2-1-0-3**

Exam Hours: 3 **Hours / Week: 02+02**

SEE: 50 Marks **Total hours: 26+26**

Course Objective:

To make students apply the concepts of CAD to develop models of machine components and CAM to obtain machined components.

Course Outcomes (COs) {with mapping shown against the **Program Outcomes (POs)**}

Upon successful completion of this course, students shall be able to:

COs	Statement	POs	PSOs
1	acquire the basic concepts of CAD/CAM with their software requirements and different geometrical modeling techniques to develop models of machine components	1, 3,5	2
2	Illustrate the concepts of CNC and CAM to write part programs for various machining operations and obtain machined components	1,2,5	-
3	Discuss the advanced manufacturing approaches to ensure optimum utilization of available resources	1, 2	-

COURSE CONTENTS:

Module-I	**07 Hrs**.
Computer Aided Design: Introduction of CAD and CAM tools, Product Life Cycle. Software configuration for graphic system, Functions of graphic package. **Principles of Computer Graphics:**Graphic primitives, Database Co-ordinate systems, 2-D Transformations of geometry, Display functions like Window, Viewport, viewing and clipping operations.	
Module-2	**07 Hrs**
Modeling Techniques: Geometrical Modeling and its importance, modeling types: solid, wireframe & surface modeling, approaches. **Mathematical representations of Surfaces:** Surface entities, Parametric representations of Analytical and Synthetic surfaces (Bezier and B-spline).	
Module-3	**07 Hrs**
Computer Aided Manufacturing: Basic components of NC, NC coordinate systems, NC motion control systems, CNC and DNC features. **CNC programming Techniques:** Part programming fundamentals, Preparatory and Miscellaneous functions, Typical examples of Drilling and Milling operations through manual part programming methods.	
Module-4	**05 Hrs**
Advanced Manufacturing Approaches: Rapid prototyping and its processes, SL, LTP, Flexible Manufacturing System, Reconfigurable Manufacturing Systems, Reverse Engineering, Lean manufacturing,	

Lab Components		Hours
Module-1	Generation of 2D Parts (sketching, and Dimensioning)	**05**
Module-2	Generation of Part modeling and Assembly practice	**07**
Module-3	CNC Drilling and Milling operation Practice	**07**
Module-4	Rapid prototyping practice	**07**
	Total hours	**26**

Text Books:

1. Michel P Groover & Emory W Zimmeres, JR, CAD & CAM, TMH, 2nd Edition, 2004, ISBN-81-203-04020-0
2. Ibrahim Zeid "S.Subramanya V. Raju, CAD & CA Theory and practice, TMH, 2nd Edition, 2010, ISBN-0-07- 463991-9

Reference Books:

1. Dr. Sadhu Singh, Computer Aided Design and Manufacturing, Khanna publishers, 2011, ISBN: 81-7409-069-3
2. P.N Rao, "CAD&CAM Principles & Application", TMH, 2nd Edition, 2004, ISBN-13-978-81-2336-8.

FLUID POWER SYSTEMS

21ME603 **LTPC: 2-0-1-3**

Exam Hours : 3 **Hours / Week : 02+02**

SEE : 50 Marks **Total hours : 26+26**

Course objective: The objective of this course is to make students design, analyze and build pneumatic and hydraulic circuits by applying the principles of fluid power transmission.

Course Outcomes (COs) with mapping shown against the **Program Outcomes (POs)**

Upon completion of the course, students shall be able to:

#	Course Outcomes	Mapping to Pos and PSos
1.	apply the principals of Pascal's law in fluid power systems and its components	1, 2, 3
2.	select appropriate hydraulic/pneumatic system components and actuators for various applications	1, 2
3.	design, analyze and simulate hydraulic/ pneumatic circuits for an application	1,3, 5, 8, 9, PSO2

Course Contents:

Module –1	**07 Hrs.**
Pneumatic Control system: Introduction to fluid power**,** Pascal's law and problems on Pascal's Law. Properties of air, gas laws, structure of pneumatic control system. Compressors: Classifications and working principles (Piston, vane and screw compressors). FRL unit ,DCV, shuttle valves, two pressure valve, PCV , FCV, quick exhaust valve, pneumatic actuators – functions and applications. **Pneumatic circuit design considerations**: Controlling of single and double acting cylinders. Design and simulation of circuits using double acting cylinders for different applications: Speed control of pneumatic actuators, door opening and closing circuit for public transport vehicle, two handed safety circuit, two step speed control system circuit for stamping operation, continuous cylinder reciprocating circuit, and application circuit for sheet folding device.	
Module – 2	**06 Hrs.**
Introduction to Hydraulic Power: Structure of hydraulic control system. Hydraulic fluids: Properties and types. Filters: Types and locations. Sealing devices: Types and materials used. Accumulators: Types and applications. Source of hydraulic power (Pumps): Classification of pumps and constructional features (gear, lobe, vane and piston pumps). Pump selection parameters. Problems on performance characteristics of pumps.	
Module – 3	**07 Hrs.**
Hydraulic Actuators: Types and constructional features (Hydraulic motors, Hydraulic cylinders), end position cushioning and mounting arrangements of cylinders. Mechanics of cylinder loading. Problems on performance of hydraulic cylinders.	
Module – 4	**06 Hrs.**
Hydraulic Control valves: Directional Control Valves – Classification, actuation methods with symbolic representations. Pressure control valves – Types with symbolic representations. Flow control valves – Types with symbolic representations. **Hydraulic circuit design considerations**: Controlling of single and double acting cylinders. Design and simulation of circuits using double acting cylinders for different applications: speed control of hydraulic actuators, regenerative cylinder circuit, counter balance valve application circuit, cylinder sequencing circuits for bending applications, automatic cylinder reciprocating circuit and hydraulic cylinder & motor synchronizing circuits.	

FLUID POWER SYSTEMS LABORATORY:

(Circuit building and simulation using automation Studio software / Pneumatic trainer kit**)**

1.	Identification and selection of various Pneumatic/Hydraliccomponents.
2.	Design and simulation of Pneumatic/Hydraulic circuits for different applications with the help of a simulation tool.
3.	Design and build Pneumatic/Hydraulic circuits for different applications with the help of trainer kit.

TEXT BOOK:

1. Anthony Esposito, *Fluid Power with Applications,* Seventh Edition, Pearson Education, Inc. 2014. ISBN: 978-93-325-1854-4.

REFERENCE BOOKS:

1. R. Srinivasan, *Hydraulic and pneumatic controls*, Second edition, McGraw Hill Education pvt. Ltd. 2009, ISBN: 978-81-8209-138-2.
2. S. R. Majumdar, *Pneumatic systems – Principles and Maintenance*, Tata McGraw Hill, 2011, ISBN-13:978-0-07-460231-7.
3. S.R. Majumdar, *Oil Hydraulic Systems - Principles and Maintenance,* Tata McGraw Hill, 2010, ISBN: 0-07-463748-7.

COURSE ARTICULATION MATRIX

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	2	-	-	-	-	-	-	-	-	-	-	-
CO2	3	2	-	-	-	-	-	-	-	-	-	-	-	-
CO3	1	-	3	-	3	-	-	3	2	-	-	-	-	3

MANAGEMENT AND ENTREPRENEURSHIP DEVELOPMENT

21ME641 **LTPC: 3-0-0-3**

Exam Hours: 3 **Hours / Week: 04**

SEE: 50 Marks **Total hours: 40**

Course Objective: To develop proficiency for making rational decisions regarding problems likely to be encountered in professional practice, by applying management concepts and entrepreneurial skills.

Course Outcomes (COs){with mapping shown against the **Program Outcomes (POs)**}

Upon successful completion of this course, the student shall be able to:

#	Course Outcomes	POs	PSOs
1	Explain the basic concepts of management and entrepreneurship	1,11	-
2	apply the conceptual knowledge of management and entrepreneurship to make rational decisions in professional practice	1,11	-
3	utilize the initiatives by government and private institutions to boost entrepreneurial spirit	1,11	-

Course Contents:

Module –1	10 Hrs.
Management: Introduction, Management Functions, levels of management, Roles of a Senior Manager, Managerial Skills, Managerial Effectiveness. **Planning:** Nature, importance and purpose of planning process, types of plans (meaning only), and steps in planning & planning premises.	
Module –2	**10 Hrs.**
Organizing: Characteristics of an Organisation, types of organization, Process of Organizing, Span of Management, Departmentalization, Committees, Authority, Responsibility, Centralization and Decentralization. Staffing: Recruitment, Selection. **Directing:** Requirements of Effective Direction. Motivation: Maslow's Need-Hierarchy Theory, Herzberg's Two-Factor Theory. Leadership styles. Coordination: meaning, importance and techniques. **Controlling:** Meaning, steps in controlling, essentials of a sound control system.	
Module- 3	**10 Hrs.**
Entrepreneurship: Introduction, steps in entrepreneurship, role of entrepreneurs in economic development, entrepreneurship in India, corporate entrepreneur ship, entrepreneurial competencies, capacity building for entrepreneurs, myths about entrepreneurship, environmental factors affecting entrepreneurial growth, creating a favorable environment for entrepreneurship.	
Module – 4	**10 Hrs.**
MSME: Role and importance, concepts and definitions, government policy initiatives for MSME, schemes for MSME, role of clusters in promoting MSME, problems in MSME sector, impact of liberalization, privatization and globalization on MSME sector, effect of WTO/GATT. Institutions	

supporting business enterprises: Central, state level and other institutions.

Self Study:

1. Prepare and present a report on business enterprises.
2. Case study on
    - Successful entrepreneurs.
    - User innovation and entrepreneurship from rural India.
    - Women entrepreneurship and the opportunity to promote India's development.
    - Information Technology and Entrepreneurship.
    - Entrepreneurship and Economic Development in a Developing Country.
    - Entrepreneurship and Innovation & Business creation and management.
    - Social Enterprise.
3. Prepare and present a report on how to utilize the resources available effectively through ERP
4. Prepare and present a report on how to make use of IPRs and institutional support in entrepreneurship

TEXT BOOKS

1. Principles of Management, P. C. Tripathi and P.N. Reddy, Tata McGraw Hill, Fifth Edition, 2012. ISBN: 978-0-07-133333-7
2. Entrepreneurship Development and Small Business Enterprises, Poornima M.Charantimath, Pearson, Third Edition, 2021

REFERENCE:

https://www.msme.gov.in/

ADDITIVE MANUFACTURING

21ME642 **LTPC: 3-0-0-3**

Exam Hours : 3 **Hours / Week : 04**

SEE : 50 Marks **Total hours : 40**

Course objectives: To understand the basic concepts of rapid prototyping, and identify their advantages, limitations and applications

Course Outcomes (COs){with mapping shown against the **Program Outcomes (POs)**}

Upon completion of the course, students shall be able to:

#	Course Outcomes	Mapping to POs	Mapping to PSOs
1.	identify the development of different rapid prototyping techniques	1,7	---
2.	describe the working principles and process parameters of additive manufacturing processes	1, 3	---
3.	interpret suitable post processing operation based on product repair requirement	1, 7	---
4.	Explore applications of different prototyping systems and develop a model using additive manufacturing processes	1, 5, 9,12	---

Course Contents:

Module – 1	**10 Hrs.**
Introduction: Prototype Fundamentals, Historical Development, Fundamentals of Rapid Prototyping, Advantages of Rapid Prototyping, Commonly Used Terms, Classifications of Rapid Prototyping System. **Rapid Prototyping Process Chain:** Fundamental Automated Processes, Process Chain. **Stereo Lithography Systems:** Principle, Process parameter, Process details, Data preparation, data files and machine details, Application.	
Module – 2	**10 Hrs.**
Selective Laser Sintering: Type of machine, Principle of operation, process parameters, Data preparation for SLS, Applications, Process parameter, Path generation, Applications. **Fusion deposition modeling:** Principle, Process parameter, Process details, Applications. **Solid Ground Curing:** Principle of operation, Machine details, Applications.	
Module –3	**10 Hrs.**
Laminated Object Manufacturing: Principle of operation, Process details, application, LOM materials. **Laser Engineered Net Shaping (LENS):** Principle of operation, Process details, applications. **Friction stirs additive manufacturing:** Process, parameters, advantages, limitations and applications.	
Module – 4	**10 Hrs.**

Post Processing of AM Parts: Support Material Removal, Surface Texture Improvement, Accuracy Improvement, Aesthetic Improvement, Preparation for use as a Pattern, Property Enhancements using Non-thermal and Thermal Techniques.

Case Studies on Rapid Prototyping Applications: Aerospace Industry, Automotive Industry, Biomedical Industry, Jewelry Industry, Coin Industry and Tableware Industry.

SELF LEARNING COMPONENT:

1. 3 D Printers, Historical Development.
2. List the materials used in development of engineering and commercial products using stereo lithography, selective sintering, fused deposition modeling and laminated object manufacturing processes.
3. Rapid Prototyping Applications: Application - Material Relationship, Finishing Processes, Applications in Design, Applications in Engineering, Analysis and Planning, Applications in Manufacturing and Tooling.
4. Realization of product by modeling simple machine parts or assembly using the 3D printing facilities in the Department.

TEXT BOOK:

1. 3D Printing and Additive Manufacturing: Principles & Applications, Chua Chee Kai, LeongKah Fai, World Scientific, 2015, 4th Edition.
2. Rapid Manufacturing: The Technologies and Applications of Rapid Prototyping and RapidTooling, D.T. Pham, S.S. Dimov, Springer 2001.
3. Additive Manufacturing Technologies: 3D Printing, Rapid Prototyping, and Direct Digital Manufacturing, Ian Gibson, David W Rosen, Brent Stucker, Springer, 2015, 2nd Edition.

REFERENCE:

1. Rapid Prototyping: Principles and Applications in Manufacturing, Rafiq Noorani, John Wiley & Sons, 2006.
2. Additive Manufacturing, Second Edition, Amit Bandyopadhyay Susmita Bose, CRC Press Taylor & Francis Group, 2020.

DESIGN OF EXPERIMENTS

21ME643 **LTPC: 3-0-0-3**

Exam Hours :0**3** Hours / Week :**03**

SEE : **50 Marks** Total hours :**40**

Course Objectives: To understand the basic concepts of design of experiments, use statistics in experimentation**,** familiar methodologies that can be used in conjunction with experimental designs for robustness and optimization.

Course Outcomes (COs) {with mapping shown against the **Program Outcomes (POs)**}

Upon completion of the course, students shall be able to:

COs	Statement	Pos
1.	identify and analyze manufacturing and design problems to obtain substantial solutions through mathematical and analytical tools	2,3,4,5
2.	apply the concepts of experimental and identify the factors relevant to the situation.	2,3,4,5
3.	plan, design, and conduct experimental investigations efficiently and effectively; choose appropriate experimental design techniques in context of the problem	2,3,4,5
4.	identify, analyze and report on a selection of advanced experimental designs using Taguchi's orthogonal array.	2,3,4,5

COURSE CONTENTS:

Module-I	**10 Hrs.**
Introduction: Strategy of Experimentation, Typical applications of Experimental design, Basic Principles, Guidelines for Designing Experiments. **Basic Statistical Concepts:** Concepts of random variable, probability, Sample and population, Concept of confidence level. Statistical Distributions: Normal, Hypothesis testing, choice of sample size. Illustration through Numerical examples.	
Module-II	**10 Hrs.**
Experimental Design: Classical Experiments: Factorial Experiments: Terminology: factors, levels, interactions, treatment combination, randomization, Two-level experimental designs for two factors and three factors. Factor interactions Illustration through Numerical. **Analysis and Interpretation Methods:** Analysis of variance (ANOVA) in Factorial Experiments. Illustration through Numerical examples.	
Module-III	**10 Hrs.**
Quality By Experimental Design: Quality, Western and Taguchi's quality philosophy, elements of cost, Noise factors causes of variation. Quadratic loss function & variations of quadratic loss function. Robust **Experiment Design Using Taguchi's Orthogonal Arrays:** Types of Orthogonal Arrays, selection of standard orthogonal arrays, linear graphs and Interaction assignment, Illustration through Numerical examples.	

Module-IV	10 Hrs.
Signal To Noise Ratio: Evaluation of sensitivity to noise. Signal to Noise ratios for static problems: Smaller-the-better type, Nominal-the –better-type, Larger-the-better type. Signal to Noise ratios for Dynamic problems. Illustration through Numerical examples. **Parameter and Tolerance Design:** Parameter and tolerance design concepts, Taguchi's inner and outer arrays, parameter design strategy, tolerance design strategy. Illustration through Numerical examples.	

TEXT BOOKS

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

REFERENCE BOOKS

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

AUTOMOTIVE ENGINEERING

21ME644 **LTPC: 3-0-0-3**

Exam Hours :0**3** Hours / Week :**03**

SEE: **50 Marks** Total hours :**40**

Course objectives: To impart knowledge on components of automotive systems and their functions

Course Outcomes (COs){with mapping shown against the **Program Outcomes (POs)**}

Upon completion of the course, students shall be able to:

#	Course Outcomes	POs
1.	describe the functional components& mechanisms of IC engines.	1,2
2.	Summarize cooling, lubrication, ignition & fuel supply systems for IC engines	1,2,7
3.	explain the importance and functions of clutch, transmission, Suspension and braking systems for IC engines.	1,2
4.	choose the fuel, mixture requirements and methods of emission control for IC engines.	1, 2,7

Course Contents:

Module – 1	10 Hrs.
Introduction: Components of an automobile, engine systems, types of engines, cylinder – arrangements, Engine Components - liners, piston, piston rings, connecting rod, cam shaft, crankshaft, valves, valve actuating mechanisms and choice of materials for different engine components. **Cooling & Lubrication Systems:** Cooling requirements, methods of cooling – air and water cooling, Objects and methods of lubrication systems.	
Module – 2	**10 Hrs.**
Ignition Systems: Requirements of an ignition system, Types - Battery and magneto ignition systems, transistor assist contacts electronic ignition, automatic ignition advance systems. **Fuels &Fuel Supply Systems for SI & CI Engines:** Normal and abnormal combustion. Mixture strength requirements of SI engines, simple carburetor, single point and multi point petrol injection systems, diesel injection system – common rail and individual pump injection methods. **Superchargers and Turbochargers:** Supercharger – types, construction detail and working principle, Turbo charger& turbocharger lag.	
Module – 3	**10 Hrs.**
Clutches: Requirements and principle of operation. Types - single plate, multi-plate and centrifugal clutches. **Transmission system:** Necessary of transmission, types – constant mesh and synchromesh gear boxes, automatic transmissions, epicyclic gear trains. **Drive To Wheels:** Propeller shaft and universal joints, final drive, differential, rear axle, rear axle drives - hotchkiss and torque tube drives. **Steering system**: Introduction, steering linkage for rigid axle and, steering gears & power steering.	

Module – 4	10 Hrs.

Suspension system: Requirements, Torsion bar suspension systems, leaf spring, coil spring, shock absorbers and air suspension system.

Brakes: Requirements, method of actuation, drum brakes, disk brakes, antilock braking systems (ABS).

Emission Control Systems: Introduction, methods of emission controls - controlling crankcase ventilation, controlling evaporative emissions, redesigning the engine, treating the exhaust gas for SI and CI engines, emission standards-

SELF LEARNING COMPONENTS:

1. Automotive electrical System: Charging system, starting system, storage batteries, lighting system, safety sensors etc.
2. Accessories: Air conditioning, power windows, central locking, vehicle tracking system, cruise control, keyless entry etc.
3. Classification and specifications of Motor cycles, four, Six, and more than Six-wheel vehicles

REFERENCE BOOKS:

1. Dr. Kirpal Singh, Automobile Engineering, Vol. 1 Standard publisher's distributors, 13th Edition 2013. ISBN: 978-81-8014-196-6.
2. Dr. Kirpal Singh, Automobile Engineering, Vol. 2 Standard publisher's distributors, 13th Edition 2014. ISBN: 978-81-8014-206-2.
3. R. B. Gupta, Automobile Engineering, SatyaPrakashan, 4th Edition.1984. ISBN: 9788176843799.
4. V. Ganesan, Internal combustion engines, McGraw-Hill education, 4th Edition 2013. ISBN: 978-1-25-900619-7.
5. N. K. Giri, Automobile Mechanics,KhannaPublisher, 8th Edition 2008. ISBN**:** 978-8174092168.

PROJECT MANAGEMENT

21ME645 **LTPC:3-0-0-3**

Exam Hours: **3** Hours/Week:**03**

SEE: **50Marks** Totalhours:**40**

Course objectives: Toimpart comprehensive understanding of how to plan, optimize and efficiently manage projects (ortasks) to implement products, services or developments.

Course Outcomes (COs) {with mapping shown against the Program Outcomes (POs)

Upon success ful completion of this course, the student shall be able to

CO's	Statement 's	PO's
1	describe project management, the project lifecycle, planning, estimating, and the project manager's roles.	1, 9, 11
2	demonstrate project organization structures, tendering and contracting processes, scheduling, and CPM and PERT.	1, 2, 9, 11
3	comprehend, how organizations enhance project management through directing, coordinating, and controlling.	1, 9, 10, 11
4	explain the importance of software efforts and techniques in project management and conduct project case studies.	1, 9, 10, 11

Course Contents:

Module–I	10 Hrs.
IntroductiontoProjectManagement: Conceptofprojectandprojectmanagement, characteristic features and classification of projects, phases of Project management, selection of project managers and their duties. **ProjectPlanningandEstimation:**Projectplanningsteps,objectivesandgoalsof The project, Feasibility reports, financing arrangements, preparationofcostestimation,evaluationmethodsforprojectprofitability.	

Module–I	10 Hrs.
Organizing and Staffing the Project Team: Authorities of project manager, organizational organizational structure and types, accountability in project execution, contracts, 3'R'sofcontracting, tendering process and selection of contractors, team building. **Project Scheduling Tools and Techniques:** Ganttchart, bar chart for combined activities, Critical path method (CPM) and Project evaluation and review technique (PERT), Numerical problems.	

Module–III.	10Hrs
Project Direction, Coordination and Control: Project direction, communication in a project, PMIS, project coordination control, schedule control & cost control. **Risk management:** Introduction, Risk Management Process, Monitoring and Control Risks. **Performance Measures in Project Management:** Performance indicators, performance improvement, The CM&DM companies for better project management, project management environment.	
Module–IV.	**10Hrs**
Software project management: Introduction, computerized project management, managing software projects, overview of capability maturity model (CMM), project management and the CMM. **Case studies on project management:** Case studies on Project planning, scheduling, tools and techniques, performance measurement.	

Self-Study Component:

- History and Evolution of Project Management
- Group of students to take up on mini project and apply various phases of project management. Prepare are port on it.
- Make survey of various oftware project manage ment tools and use any one tool.

TextBook:

1. Project Managementa System approach to planning Scheduling & Controlling- Harold Kerzner, 10th edition 2009, John Wiley &sons.
2. Chaudhry S,Project Execution Plan-Plan for project Execution interaction,2001

ReferenceBooks:

1. Software Project Management in Practice-PankajJalote, Pearson education
2. Fundamentals of Project Management: Rory Burke, 2010,Burke Publishing.
3. Project planning scheduling & control, James P.Lawis, Meo Publishing Company, 5th edition 2010.
4. A Management Guide to PERT and CPM, WEIST& LEVY-Eastern Economy of PHI2002.

MALNAD COLLEGE OF ENGINEERING, HASSAN
(An Autonomous Institution Affiliated to VTU, Belgaum)

QUALITY CONTROL AND MANAGEMENT

21ME651 **LTPC:3-0-0-3**
Exam Hours: **3** Hours/Week:**03**
SEE: **50Marks** Totalhours:**40**

Course objective: To make students apply quality management concepts and statistical process control techniques to improve quality.

Course Outcomes (COs) {with mapping shown against the **Program Outcomes (POs)**}

Upon successful completion of this course, the student shall be able to:

#	Course Outcomes	Mapping to POs	Mapping to PSOs
1	explain the basic concepts of quality management	1,2	-
2	apply statistical process control techniques to control the quality standards	2	-
3	develop and interpret control charts	2	-

COURSE CONTENTS:

Module – 1	**10 Hrs.**
Quality Management: Introduction, basic approach, TQM framework, different dimensions of quality, historical review and Deming's philosophy. Continuous Quality Improvement Tools: PDSA cycle, Juran quality trilogy, Kaizen, benchmarking, steps involved in benchmarking process, 5S, 3M and poka-yoke.	
Module – 2	**10 Hrs.**
Statistical Process Control: Introduction, pareto diagram, process flow charts, cause and effect diagram. Statistical fundamentals: Six sigma, process capability, chance and assignable causes of quality variations, statistical basis for the control charts.	
Module – 3	**10 Hrs.**
Control charts for variables: Development and interpretation of $\bar{X}$&Rcharts:Process Capability Estimating, Process capability ratio, Fraction of nonconforming, Revision of Control Limits and Center Lines, Control Limits, Specification Limits and Natural Tolerance Limits.Development of$\bar{X}$&R charts.	
Module – 4	**10 Hrs.**
Control Charts for Attributes: Introduction, control charts for fraction defectives, development of control charts for constant sample size & variable sample sizes, and control charts for defects. Guidelines for implementing control charts, construction, applications and interpretation of p – chart, np – chart and C –chart. **Acceptance Sampling:** Introduction, Types of Sampling Plan.	

SELF LEARNING COMPONENT:

- Quality management systems: Quality management principles, development of ISO 9000 series standards, ISO 9001:20015 requirements, implementation of ISO 9001:20015, comparison between ISO 9001:20015 and ISO 9001:2000, documentation, certification, benefits of ISO certification.
- Environmental management systems: Importance of ISO standards, ISO standards for different sectors, environmental management systems, ISO 14000 series standards, concepts of ISO 14001, requirements of ISO 14001:2015, implementation of ISO 14001:2015, benefits of environmental management system, documentation and, certification.

Text Books:

1. Dale H. Bester field, Total Quality Management, Pearson Education India, ISBN: 978-81-317-3227-4, Edition 03/e Paperback (Special Indian Edition)
2. Douglas C. Montgomery, Introduction to Statistical Quality Control, John Wiley & Sons, Inc. 2017. ISBN: 0-07-844354-7

Reference Books:

1. M. Zairi, Publisher, Total Quality Management for Engineers, Wood head Publishing, ISBN: 1855730243
2. Manohar Mahajan, Statistical Quality Control, Dhanpat Rai and Sons, New Delhi, 2018.
3. E.L. Grant, and R.S. Leavenworth, Statistical Quality Control, Seventh Edition, TMH, New Delhi, 2016. ISBN: 0-07-114248-7

MALNAD COLLEGE OF ENGINEERING, HASSAN
(An Autonomous Institution Affiliated to VTU, Belgaum)

INDUSTRIAL AUTOMATION

21ME652 **LTPC:3-0-0-3**
Exam Hours: **3** Hours/Week:**03**
SEE: **50Marks** Totalhours:**40**

Course Objective: To make students apply the principles and strategies of automation while creating a new facility or upgrading the existing one.

Upon successful completion of this course, the student shall be able to:

COs	Statement	Pos
1.	apply the concepts of automation, principles and strategies	1, 3
2.	explain the fundamentals of robotics and discrete control	1, 5
3.	explain the considerations in material handling system design and concepts of group technology and cellular manufacturing	1
4.	apply the concepts of FMS, design for automated assembly, process planning and concurrent engineering	1

COURSE CONTENTS:

Module – 1	10 Hrs.
Automation: Introduction, Automation Principles and strategies, Basic elements of an automated system, advanced automation functions, Levels of automation. Production concept and mathematical models: Introduction, Production rate, Production capacity, Utilization and availability, Manufacturing lead time, (simple problems using these models).	
Module – 2	**10 Hrs.**
Industrial Robotics: Introduction, Robot anatomy and related attributes, Robot control systems, end effectors, sensors in robotics, Industrial robot applications. **Discrete control using programmable logic controllers and personal computers:** Discrete process control, ladder logic diagrams, PLC-components, operating cycle, additional capabilities, programming, personal computers using soft logic	
Module – 3	**10 Hrs.**
Material Handling: Introduction to Material handling equipment, Considerations in material handling system design, The 10 principles of Material handling. **Introduction to Manufacturing Systems:** Components and classification of manufacturing systems, overview of the classification scheme. **Group Technology and Cellular Manufacturing:** Manufacturing process functions (learning curves), part families, parts classification and coding, Production Flow Analysis, Cellular Manufacturing and application considerations in GT.	
Module – 4	**10 Hrs.**
FMS and Automated Assembly systems: Definition, components, application and benefits of FMS, Fundamentals of Automated Assembly systems, Design for automated assembly. **Process planning, concurrent engineering and advanced automation:** Process planning, CAPP, CE and Design for manufacturing, Advanced manufacturing planning. Smart manufacturing and Industry 4.0	

Self-study component:

Using the best internet search Engines Carryout of the following 4 Activities with Proper Video/PPT. Finally two best Activities will be picked for evaluation. All Activities carry 5 marks each:

1. Provide the History of Manufacturing & Automation that drove Industrial Revolution
2. Select one real application of Automation / Robotics in the field of Latest Technology Development and Industry-4.0 & Industry-5.0 relevant (such as Agriculture, Digital Society, Medical, Military, and Manufacturing Applications etc.)
3. Write down the Ladder diagram with electrical circuits of advanced manufacturing applications.
4. Using latest studies prepare a detailed brief report of Industry 4.0 and future World class manufacturing.

Textbooks:

1. Mikell .P. Groover, "**Automation, Production Systems and Computer Integrated Manufacturing**", Fourth Edition, Pearson Education, Limited, 2015. ISBN: 1292076119, 9781292076119.

2. S. Kant Vajapayee, "**Principles of Computer-integrated Manufacturing**", PHI, 1995. ISBN: 0024222410, 9780024222411.

3. Vishwanadham and Narahari, "**Performance Modeling of Automated Manufacturing Systems**", PHI,2005, ISBN: 8120308700, 9788120308701.

MALNAD COLLEGE OF ENGINEERING, HASSAN
(An Autonomous Institution Affiliated to VTU, Belgaum)

FUNDAMENTALS OF TRIBOLOGY

21ME653 **LTPC:3-0-0-3**
Exam Hours: **3** Hours/Week:**03**
SEE: **50Marks** Totalhours:**40**

Course objectives: To impart the knowledge of basic principles of friction, wear and lubrication and its importance in selection of machine elements.

Course Outcomes (COs) {with mapping shown against the **Program Outcomes (POs)**}

Upon completion of the course, students shall be able to:

#	Course Outcomes	Mapping to POs	Mapping to PSOs
1.	describe basic phenomena related to friction, wear and lubrication	1	-
2.	study the effects of friction, wear, and lubrication in metal working process	1,2	-
3.	identify and operate the measuring instruments for tribology	1,9	-

Course Contents:

Module – 1	**10 Hrs.**
Introduction to Tribology: Definition and History of Tribology**,** industrial significance of tribology, Significance of Micro/Nanotribology. **Friction:** Material properties influencing friction, laws of friction, causes/theories of friction, Types of friction, effects of friction. **Wear:** Causes/sources of wear, types of wear (adhesive, abrasive, and corrosive, erosive, fretting), effects of wear, steps for wear prevention/resistance, Wear measurement.	
Module – 2	**10 Hrs.**
Lubrication: Lubrication principles/types **Hydrodynamic Lubrication:** Pressure development mechanism, converging and diverging film, Petroff's equation, Reynolds 2D and 3D equations, Numerical examples on determining rate of flow and coefficient of friction. **Hydrostatic Lubrication**: Introduction to hydrostatic lubrication, hydrostatic step bearings, load carrying capacity & oil flow through the hydrostatic step bearing, Numerical examples on determining rate of flow and coefficient of friction.	
Module – 3	**10 Hrs**
Tribology in Metal Working Process: Effect of friction in metal working, Wear and lubrication in rolling, Wear and lubrication in extrusion, Wear and lubrication in forging, Wear and Lubrication in Metal cutting. **Future directions of Tribology:** Nanotribology- basic concepts, Applications of nanotribolgy, Principles of Green Tribology, Areas of Green Tribology. Biotribology, Environmental implications of tribology.	

Module – 4	10 Hrs.

Friction and wear measurements: Laboratory experiments/demonstrations:

- Evaluation of Friction and wear behavior using Pin on Disc Tribometer (ASTM G99).
- Evaluation of Corrosion properties of Lubricants using Copper Strip Corrosion Method (ASTM D130).
- Evaluation of Tool wear using Tool Maker's Microscope.
-

SELF-STUDY:

Scientific Article Review:

An article review is both a summary and an evaluation of another writer's article. This activity is assigned to introduce students to the work of Researchers/Academicians in the field of Tribology.

TEXTBOOKS:

- Stachowiak, Gwidon, and Andrew W. Batchelor. Engineering tribology. Butterworth-Heinemann, 2013. ISBN: 7506-7836-4
- Bharat Bhushan. Principles and Applications of Tribology., John Wiley & Sons, 2013Ltd. ISBN: 9781119944546
- Sushil Kumar Srivastava. Tribology in Industries: S. Chand & Company Ltd. 2001. ISBN 81-219-2045-0

REFERENCE BOOKS:

- B.C. Majumdar, Introduction of Tribology of bearings, Wheelers, and company Pvt. Ltd., 2011-12. ISBN:81-219-29870

MALNAD COLLEGE OF ENGINEERING, HASSAN
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MICRO-ELECTRO MECHANICAL SYSTEMS

21ME654 **LTPC:3-0-0-3**
Exam Hours: **3** Hours/Week:**03**
SEE: **50Marks** Totalhours:**40**

Course Objective: To study various MEMS fabrication technologies and applications of Micro-sensors and Micro-actuators

Course Outcome
Upon successful completion of this course, students should be able to:

COs	Statement	POs	PSOs
CO1.	describe the working principles of micro sensors, actuators, motors, valves, pumps, and fluidics used in Microsystems	1, 2	
CO2.	Compreh end the use of common micro components and devices used in medical application.	2, 3	
CO3.	select suitable micromachining techniques for specific MEM`S fabrication process	2,7	
CO4.	analyze the concept related to optical, RF, Magnetic devices and application of MEM in Miniaturization.	2,4,5	

Course Contents:

Module – 1	**10 Hrs.**
Introduction: Background and Introduction, Production Engineering, Precision and Ultra-Precision Engineering, Integrated circuits, Micro electro mechanical systems. Application of MEMS and micro system in Bio-Medical Industry. **Micro Machining:** Introduction, Photolithography, structural and sacrificial materials, other lithography methods, thin film deposition, impurity doping, etching, problems with bulb micro-maching, surface micro-maching, wafer bonding.	
Module – 2	**10 Hrs.**
Mechanical Sensors and Actuators: System on A Chip, Passive Electronic and Mechanical Systems, Principles of Sensing and Actuation, Beam and Cantilever, Micro plates, Capacitive effects, piezo electric materials as sensing and actuating elements, Shear mode piezo actuator, griping piezo actuator, inchworm technology. **Thermal Sensors And Actuators :** Introduction, micro machined thermo couple probe, Peltier effects heat pumps, thermal flow sensors, micro plate gas sensors, MEMS thermo vessels, pyro electricity, shape memory alloys, U-shaped horizontal and vertical electro thermal actuator, thermally activated MEMS relay, micro spring thermal actuator, data storage cantilever.	
Module – 3	**10 Hrs**
Micro-Opto-Electro Mechanical Systems: Fundamental principle of MOEMS technology, review on properties of light, light modulators, beam splitter, micro lens, micro mirrors, digital micro mirror device, light detectors, grating light valve, optical switch, wave guide and tuning. **Magnetic Sensors and Actuators:** Magnetic materials for MEMS and properties, magnetic sensing and detection, magneto restrictive sensors, magneto diodes, magneto transistors, Bi-directional microactuator, large force reluctant actuator.	

Module – 4	10 Hrs.

Radio Frequency MEMS Review of RF based communication systems, RF MEMS, MEMS inductors, varactors, tuner/filter, resonator, MEMS switches, phase shifter

Micro Fluidic, Chemical and Bio-Medical Micro Systems: Introduction Applications, important consideration on micro scale fluid. Properties of fluids, fluid actuation methods, electo wetting, thermo capillary effect, and electro osmosis flow, chemo resistors, capacitors, transistors, DNA sensors, Carbon Nano Tube, applications of CNTs

SELF-STUDY:

Scientific Article Review:

An article review is both a summary and an evaluation of another writer's article. This activity is assigned to introduce students to the work of Researchers/Academicians in the field of Tribology.

TEXTBOOKS:

1. Mahalik, Nitaigour Premchand, MEMS, Tata McGraw Hill Publishing Company Ltd. ***ISBN 13: 9780070634459***.

REFERENCE BOOKS:

1. HSU, MEMS, Prentice Hall of India.SBN-13: ***978-0072393910***
2. Nadim Maluf, An Introduction to Micro electromechanical Systems Engineering, Artech House Publishers, 2000. ISBN-13 :978-1580535908
3. Stephen D. Senturia, "Microsystems Design" Kluwer Academic Publishers, New York, November 2000. ISBN-13 978-0792372462
4. 4.M.H. Bao, “Micromechanical Transducers: Pressure sensors, Accelerometers, and gyroscopes” Handbook, Elsevier.ISBN-13. 978-0444543547

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MALNAD COLLEGE OF ENGINEERING, HASSAN
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ELECTRIC VEHICLE TECHNOLOGY

21ME655 **LTPC: 3-0-0-3**
Exam Hours :0**3** Hours / Week :**03**
SEE : **50 Marks** Total hours :**40**

Course Objective: To equip students with fundamental knowledge of Electric Vehicle design and technology, energy storage, charging and discharging, BLDC Motor and controller and calculations.

Course Outcomes (COs) {with mapping shown against the **Program**

Outcomes (POs)}upon completion of the course, students shall beable to:

#	Course Outcomes	Mappingto POs	Mapping toPSOs
1.	Apply basic laws and working principles of Electric vehicle system	1,2,3	-
2.	Select appropriate motor and converter for EV application.	2,3	-
3.	Analysis and selection of energy storage system and battery indication system for EV vehicles	2,3,7	-
4.	Evaluate the parameters for charging station and Recycling the batteries.	2,3,7	-

Course Contents:

Module– 1	**10 Hrs.**
Introduction to EV: HistoryofEVVehiclesandbasicconcepts,socialandenvironmentalimportanceof EVvehicles, Configuration of Electric Vehicles, Performance of Electric Vehicles, Tractive effort and Transmission requirement, Energy consumption Concept of Hybrid Electric Drive Trains.	
Module - 2	**10 Hrs.**
Electric Drives:EV consideration, DC motor drives and speed control, Induction motor drives, Permanent Magnet Motor Drives, Switch Reluctance Motor Drive for Electric Vehicles, Configuration and control of Drives. Fundamentals of battery management system (BMS) and controls.	
Module-3	**10 Hrs.**
Energy Storage System: Introduction to Energy Storage Requirements in Hybrid and Electric Vehicles: - Battery based energy storage and its types (Lead acid, Nickel based, Sodium based, Lithium based, I-ion and Li-poly, Metal air, Zinc chloride, Ultra capacitors, Lithium phosphate, Titanate) Fuel Cell based energy storage. Hybridization of different energy storage devices. Design of Hybrid Electric Vehicle and Plug-in Electric Vehicle. Comparison of different energy storage systems.	

Module-4	**09 Hrs.**
Battery Recycling Technologies::Technology and economic aspects of battery recycling Battery Applications for Stationary and Secondary Use. **Electric Vehicles charging station:** Type of Charging station, Selection and Sizing of charging station, Components of charging station.	

SELFSTUDY:

1. Basic Working Principles of motors
2. Energy charging and discharging
3. BMS(Battery Management System)
4. Simple Calculation of EV Drive
5. To make battery pack with different cells

TEXTBOOKS:

1. Electric and Hybrid vehicles by A.K.Babu, khanna publications
2. Electric vehicle and the end of ICE age by Anupam Singh
3. EVT by James Larminie Oxford Brookes University, UK John Lowry Consultant Engineer, Swindon, UK

REFERENCESBOOKS:

1. Electric and HybridevehiclesbyTomDentonISBN978-1-138-84237-3
2. Modernekectric, hybrid electric and fuel cell vehicles by Mehrdadehsani,Yimingao, stdfanolongo, kambizebrahimimi. ISBN 0-8493-3154-4
3. M.Ehsani,Y,Gao,S.GayandAliEmadi:ModernElectricandHyubrideVehicleandFuelcell vehicle, Fundamental theory and design CRC Press,2005
4. Iqbal Husain: Electric and hybridevehicle design and fundamentals.
5. Jameslarmine, johnlpwry: Electric vehicle technology explained

E-Books/Web References:

www.wiley.com/go/electricvehicle2e

MALNAD COLLEGE OF ENGINEERING, HASSAN
(An Autonomous Institution Affiliated to VTU, Belgaum)

PRINCIPLES OFMANUFACTURING

21OEME61 **LTPC:3-0-0-3**
Exam Hours: **3** Hours/Week:**03**
SEE: **50Marks** Totalhours:**40**

Course objectives: To equip students of other engineering disciplines with the fundamental aspects of manufacturing processes and their applications

Course Outcomes (COs) {with mapping shown against the **Program Outcomes (POs)**}

Upon successful completion of this course, the student shall be able to:

#	Course Outcomes	Mapping to POs	Mapping to PSOs
1	realize the role of manufacturing processes in other engineering branches and learn principles of different metal forming processes	1	-
2	comprehend the basic principles and recent developments of modern manufacturing processes	1, 5	-
3	realize the significance of various joining and assembly techniques	1	-
4	infer the basic concepts and applications of rapid prototyping	1, 5	-

Course Contents:

Module – 1	10 Hrs.
Introduction and overview of manufacturing: History and concepts of manufacturing, Materials in manufacturing, Classification of manufacturing processes. **Fundamentals of metal forming:** Overview of metal forming, working principle, advantages, limitations and applications of rolling, forging, extrusion, wire and bar drawing, sheet metal operations – shearing, blanking and punching, bending operations – V and Edge bending, drawing, bending of tube stock.	
Module – 2	**10 Hrs.**
Fundamentals of material removal: Traditional vs. Non-traditional machining process, working principle, advantages, limitations and applications of ultrasonic machining, abrasive jet machining, electrochemical machining - deburring, grinding and honing, chemical machining, laser beam machining, electron beam machining.	

Module – 3	10 Hrs.
Fundamentals of joining and assembly processes: Working principle, advantages, limitations and applications of electron beam welding, laser beam welding and ultrasonic welding. **Adhesive bonding:** Materials and their properties, advantages, limitations and applications. **Coatings:** Painting, paint application methods, chemical conversion coatings, electroplating, anodizing, electro less plating, mechanical plating, porcelain enameling, clad materials.	
Module – 4	**09 Hrs.**
Rapid Prototyping: Fundamentals of rapid prototyping, rapid prototyping technologies, application issues in rapid prototyping. **Applications of rapid prototyping:** Processing of integrated circuits, electronics assembly, and packaging, micro fabrication technologies, and nanofabrication technologies.	
SELF-STUDY: 1. Simulation of manufacturing processes through online virtual labs. ➢ https://3dp-dei.vlabs.ac.in/List%20of%20experiments.html ➢ http://msvs-dei.vlabs.ac.in/upsetting_simulation.php ➢ http://mm-coep.vlabs.ac.in/ ➢ http://vlabs.iitkgp.ac.in/psac/newlabs2020/vlabiitkgpAM/# ➢ http://vlabs.iitkgp.ac.in/psac/newlabs2020/vlabiitkgpMM/ 2. Preparation of reports on the simulation and presentations to be made in a group.	
TEXT BOOK: 1. Mikell, P. Groover. Fundamentals of modern manufacturing: materials, processes and systems. JOHN WILEY, 2019.	
REFERENCE BOOKS: 1. Black, J. Temple, and Ronald A. Kohser. DeGarmo's materials and processes in manufacturing. John Wiley & Sons, 2017. 2. Pham, Duc, and Stefan S. Dimov. Rapid manufacturing: the technologies and applications of rapid prototyping and rapid tooling. Springer Science & Business Media, 2012. 3. Production Technology, HMT TATA McGraw Hill 2001 ISBN-0070764432. 4. Adityan, Modern Machining Process, 2002. ISBN-85143774 -11.	

MALNAD COLLEGE OF ENGINEERING, HASSAN
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INDUSTRIAL ENGINEERING AND ERGONOMICS

21OEME62 **LTPC:3-0-0-3**
Exam Hours: **3** Hours/Week:**03**
SEE: **50Marks** Totalhours:**40**

Course objectives: To provide the basic knowledge of productivity and method study, work measurement and ergonomics in various sectors and its effectiveness in improvement of productivity.

Course Outcomes (COs){with mapping shown against the **Program Outcomes (POs)**}

Upon successful completion of this course, the student shall be able to:

#	Course Outcomes	Mapping to POs	Mapping to PSOs
1.	explain the fundamental concepts of productivity and work study	1, 6,11	-
2.	compare and prepare the charts for the existing method and new / proposed method to identify the unnecessary movements.	2, 6,11	-
3.	apply the concepts of work measurement to solve problems related to work measurement and performance of workers	2, 6	-
4.	apply the ergonomic concepts in design of new systems, displays and controls	3, 6	-

COURSE CONTENTS:

Module – 1	10 Hrs.
Productivity and work study: Definition of productivity, Production and productivity, expectations from productivity, benefits from productivity, productivity measures, advantages and limitations of productivity measures, Factors affecting the productivity, Productivity improvement programmes (Simple Problems). Basic work content. Definition, objective and scope of work-study. Human factors in work study. Work study and management, work study and supervision, work study and worker.	
Module – 2	**10 Hrs.**
Method Study and Tools for Method study: Definition, objective and scope of method study, activity recording and exam aids. Charts to record moments in shop operation – process charts, flow process charts, travel chart and multiple activity charts (Problems). Charts to record moment at workplace – principles of motion economy, classification of moments, two handed process chart, SIMO chart, (Problems)	
Module – 3	**10 Hrs.**
Work Measurement: Definition, objectives, preparing to measure process work, techniques of work measurement, types of elements, time study equipments, performance rating, allowances, computation of standard time, comparison of various techniques, work sampling, synthetic data, predetermined motion time analysis(PMTS)	

Module – 4	**10 Hrs.**
Ergonomics and Design of Man-Machine System: Introduction, areas of study under ergonomics, System approach to ergonomics model, Man-machine system. Components of man-machine system and their functions Quantitative, qualitative representation and alphanumeric displays. Controls and their design criteria, Control types, Relation between controls and displays. Design of workplace.	
SELF STUDY: 1. Study of occupational loads 2. Study in detail about working space and working environment. 3. Working environment factors 4. Anthropometry and its importance 5. Risk factors for musculoskeletal disorders in the workplace 6. Predetermined motion time system techniques and development of PMT system	
TEXT BOOKS: 1. Industrial Engineering and Production Management, Martand T Telsang, 3rd edition, 2018. ISBN 978-93-525-3379-4 2. Work Study & Ergonomics, Suresh Dalela& Saurabh, standard publishers & distributors. ISBN 9780850660085	
REFERENCE BOOKS: 1. Introduction to Ergonomics, R. C. Bridger, McGraw Hill Publications. ISBN 978-0-8493-7309-0 2. Industrial Design for Engineers, Mayall W. H. London Hiffee Books Ltd., 1988. ISBN -10-0592042057 3. Human Factor Engineering: Sanders & McCormick McGraw Hill Publications. ISBN 08403 16240	

MALNAD COLLEGE OF ENGINEERING, HASSAN
(An Autonomous Institution Affiliated to VTU, Belgaum)

PROJECTMANAGEMENT	
21OEME63	**LTPC:3-0-0-3**
Exam Hours: **3**	Hours/Week:**03**
SEE: **50Marks**	Totalhours:**40**

Course objective: To make students apply quality management concepts and statistical process control techniques to improve quality.

Course Outcomes (COs) {with mapping shown against the **Program Outcomes (POs)**}

Upon successful completion of this course, the student shall be able to:

#	Course Outcomes	Mapping to POs	Mapping to PSOs
1	explain the basic concepts of quality management	1,2	-
2	apply statistical process control techniques to control the quality standards	2	-
3	develop and interpret control charts	2	-

COURSE CONTENTS:

Module – 1	**10 Hrs.**
Quality Management: Introduction, basic approach, TQM framework, different dimensions of quality, historical review and Deming's philosophy. Continuous Quality Improvement Tools: PDSA cycle, Juran quality trilogy, Kaizen, benchmarking, steps involved in benchmarking process, 5S, 3M and poka-yoke.	
Module – 2	**10 Hrs.**
Statistical Process Control: Introduction, pareto diagram, process flow charts, cause and effect diagram. Statistical fundamentals: Six sigma, process capability, chance and assignable causes of quality variations, statistical basis for the control charts.	
Module – 3	**10 Hrs.**
Control charts for variables: Development and interpretation of $\bar{X}$&Rcharts: Process Capability Estimating, Process capability ratio, Fraction of nonconforming, Revision of Control Limits and Center Lines, Control Limits, Specification Limits and Natural Tolerance Limits.Development of$\bar{X}$&R charts.	
Module – 4	**10 Hrs.**
Control Charts for Attributes: Introduction, control charts for fraction defectives, development of control charts for constant sample size & variable sample sizes, and control charts for defects. Guidelines for implementing control charts, construction, applications and interpretation of p – chart, np – chart and C –chart. **Acceptance Sampling:**Introduction, Types of Sampling Plan.	

SELF LEARNING COMPONENT:

- Quality management systems: Quality management principles, development of ISO 9000 series standards, ISO 9001:20015 requirements, implementation of ISO 9001:20015, comparison between ISO 9001:20015 and ISO 9001:2000, documentation, certification, benefits of ISO certification.
- Environmental management systems: Importance of ISO standards, ISO standards for different sectors, environmental management systems, ISO 14000 series standards, concepts of ISO 14001, requirements of ISO 14001:2015, implementation of ISO 14001:2015, benefits of environmental management system, documentation and, certification.

Text Books:

4. Dale H. Bester field, Total Quality Management, Pearson Education India, ISBN: 978-81-317-3227-4, Edition 03/e Paperback (Special Indian Edition)
5. Douglas C. Montgomery, Introduction to Statistical Quality Control, John Wiley & Sons, Inc. 2017. ISBN: 0-07-844354-7

Reference Books:

3. M. Zairi, Publisher, Total Quality Management for Engineers, Wood head Publishing, ISBN: 1855730243
4. Manohar Mahajan, Statistical Quality Control, Dhanpat Rai and Sons, New Delhi, 2018.
6. E.L. Grant, and R.S. Leavenworth, Statistical Quality Control, Seventh Edition, TMH, New Delhi, 2016. ISBN: 0-07-114248-7

MALNAD COLLEGE OF ENGINEERING, HASSAN
(An Autonomous Institution Affiliated to VTU, Belgaum)

OCCUPATIONAL HEALTH AND SAFETY ENGINEERING

21OEME64 **LTPC:3-0-0-3**
Exam Hours: **3** Hours/Week:**03**
SEE: **50Marks** Totalhours:**40**

Course objectives: To apply the basic concept of occupational health and safety standards in work place scenario.

Course Outcomes (COs) {with mapping shown against the **Program Outcomes (POs)**}

Upon completion of the course, students shall be able to:

COs	Course Outcomes	Mapping to POs	Mapping to PSOs
1.	interpret legislative requirements, industry standards, and best practices in a variety of workplaces and also workplace accidents and injuries.	6,7,12	-
2.	Applyrisk management principles to anticipate, assess, mitigate, and manage various physical, chemical, biological, psychosocial, and ergonomic hazards.	6,7,11	-
3.	evaluation of fire hazards and risks in the workplace, while providing guidance and recommendations on fire safety management.	6,7	-
4.	ApplyOSHA exposure limits and work place standard to health hazard, and implement OHS management systems, and promote a culture of safety within organization/industries.	6,7,11	-

Course Contents:

Module – I	10 Hrs.
Occupational Hazard and Control Principles: Safety, History and development, National Safety Policy. Occupational safety and Health Act (OSHA), Indian Acts – Labor Act, Factories Act, Occupational Health and Safety administration - Laws governing OSHA and right to know laws. Accident – causation, investigation, investigation plan, Methods of acquiring accident facts, Supervisory role in accident investigation.	
Module – II	**10 Hrs.**
Ergonomics at Work Place: Ergonomics Task analysis, Preventing Ergonomic Hazards, Work space Envelops, Visual Ergonomics, Ergonomic Standards, and Ergonomic Programs. Hazard cognition and Analysis, Human Error Analysis – Fault Tree Analysis – Emergency Response - Decision for action – purpose and considerations. Hazards and their control in different manufacturing and processing industries.	

Module – III	10 Hrs.
Fire Prevention and Protection: Fire Triangle, Fire Development and its severity, Effect of Enclosures, early detection of Fire, Classification of fire and Fire Extinguishers. **Electrical Safety, Product Safety:** Technical Requirements of ElectricalandProduct safety.	
Module – IV	**10 Hrs.**
Occupational Health and Safety Considerations: Types of diseases and their spread, Health Emergency. Personal Protective Equipment(PPE) – types and advantages, Health problems in different types of industries – construction, textile, iron and steel and food processing, pharmaceutical, occupational Health and Safety considerations in Wastewater Treatment Plants. Environment management plans (EMP) for safety and sustainability.	

SELF STUDY:
Prepare a report on: workplace ergonomics, fire safety, workplace violence prevention, employee health resources, and environmental safety.

TEXT BOOK:

1.Goetsch D.L., "Occupational Safety and Health for Technologists, Engineers and Managers", Prentice Hall.
2. Heinrich H.W., "Industrial Accident Prevention", McGraw Hill Publication.

REFERENCE:

1.Colling D.A., "Industrial Safety Management and Technology", Prentice Hall, New Delhi.
2. Della D.E., and Giustina, "Safety and Environmental Management", Van Nostrand Reinhold International Thomson Publishing Inc.
3. CPHEEO, Manual on Sewerage and Sewage Treatment, M/s.Jain Book Agency, c-9, Connaught place, New Delhi.
4. "Industrial Safety and Pollution Control Handbook" National Safety Council and Associate (Data) Publishers Pvt. Ltd.,

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HEAT TRANSFER LABORATORY

21ME606 **LTPC: 0-0-2-1**
Exam Hours :**3** Hours / Week :**02**
SEE: **50 Marks** Total hours :**28**

Course objective:
To demonstrate the concepts of modes of heat transfer through collection of data, analysis and interpretation of results for drawing valid conclusions

Course Outcomes (COs){with mapping shown against the **Program Outcomes (POs)**}

Upon completion of the course, students shall be able to:

COs	Statement	POs
1.	conduct experiments on conduction, convection and radiation modes of heat transfer: collect data, perform analysis and interpret results to draw valid conclusion through standard test procedures.	2, 3, 7 10
2.	estimate the thermal properties and performance of refrigeration, Air conditioning and heat exchanger.	2,3, 7,10

COURSE CONTENTS:

1. Determination of Thermal conductivity of a Metal rod.
2. Determination of Thermal conductivity of liquid
3. Determination of overall heat transfer coefficient of a Composite Wall.
4. Determination of Heat Transfer co-efficient in a free convection wall.
5. Determination of Heat Transfer co-efficient in a forced convention flow through a pipe.
6. Experiments on Boiling of liquid and condensation of vapour
7. Determination of efficiency and Effectiveness of the fin by natural convection using pin fin apparatus
8. Determination of efficiency and Effectiveness of the fin by forced convection using pin fin apparatus.
9. Determination of Stefan Boltzmann constant
10. Determination of emissivity of a surface.
11. Determination of LMTD and effectiveness in a parallel flow and counter flow Heat exchanger.
12. Performance Test on a Vapour Compression Refrigerator.

SEE Scheme:

1.	Individual Experiment - one question	15 Marks
2.	Group Experiment - one question	25 Marks
3.	Viva Voce	10 Marks
	Total:	50 Marks

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Course Title	**MINI PROJECT**		
Course Code	**21ME509**	**LTPC**	**0-0-4-2**

Course Objectives: To take part in group to demonstrate the acquired skill & knowledge gained to identify, formulate, analyze, evaluate and to provide meaningful engineering solutions to Industrial/societal needs.

Course Outcomes (COs) {with mapping shown against the **Program Outcomes (POs)**}

Upon successful completion of this course, the student shall be able to:

#	Course Outcomes	Mapping to POs	Mapping to PSOs
1.	identify thrust areas in field of Mechanical or allied areas of Engineering	4, 6,7	-
2.	generate and implement innovative ideas for social benefit	1, 2, 4, 5	-
3.	Conducting preliminary Analysis / Modeling /Simulation / Experiment / Design / Feasibility	4, 5, 6, 8, 9, 10, 11, 12	-
4.	prepare a report on the Study conducted for presentation	10,12	-

The objective of Mini Project is to enable the student to take up investigative study in the broad field of Mechanical Engineering, either fully theoretical/practical or involving both theoretical and practical work to be assigned by the department on an individual basis or two/three students in a group, under the guidance of a supervisor. This is expected to provide a good initiation for the student(s) in R&D work. The mini project is designed to develop practical ability and knowledge about tools/techniques in order to solve the actual problems related to the industry, academic institutions or similar area. The mini project should be undertaken preferably by a group of minimum two and maximum four students who will jointly work together and implement the project. Students can take up any application level/fabrication level/ experimental design / implementation tasks of relatively minor intensity and scope as compared to the major-project, pertaining to a relevant domain of study. Projects can be chosen either from the list provided by the faculty or in the field of interest of the student. At the end of each phase, presentation and demonstration of the project should be conducted, which will be evaluated based on the rubrics set by the department under the committee of HOD, one professor, one Associate professor and one Assistant Professor. A detailed project report duly approved by the guide in the prescribed format should be submitted by the student for final evaluation.

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SCHEME OF EVALUATION

FIRST PHASE		MAX MARKS: 10
Sl. No.	**Particulars**	**Distribution of Marks**
1.	Literature Survey (Team)	5
2.	Presentation skill (Individual)	3
3.	Viva voce (Individual)	2

SECOND PHASE		Max Marks: 15
Sl. No.	**Particulars**	**Distribution of Marks**
1.	Problem formulation (Team)	5
2.	Methodology followed (Team)	5
3.	Presentation skill (Individual)	3
4.	Viva voce (Individual)	2

THIRD PHASE		Max Marks: 25
Sl. No.	**Particulars**	**Distribution of Marks**
1.	Observations / modelling/Study etc. (Team)	6
2.	Results & Discussion (Team)	6
3.	Conclusions (Team)	5
4.	Presentation skill (Individual)	5
5.	Viva voce (Individual)	3

Examination	Maximum marks	Minimum marks to qualify
CIE	**100**	**40**

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Course Title	**ENVIRONMENTAL STUDIES**		
Course Code	**21EVS**	**LTPC**	**0-1-0-0**
Teaching hours	**26 Hours**	**Hours / Week**	**02**

Course Outcomes (COs) {with mapping shown against the **Program Outcomes (POs)**}

Upon successful completion of this course, the student shall be able to:

#	Course Outcomes	Mapping to POs	Mapping to PSOs
1.	apply the dimension of the societal health, safety, legal and cultural issues as engineer to the given problem of environmental concern.	6, 8	-
2.	evaluate the need for sustainable development having understood the adverse effects of present day development on the environment.	7, 12	-
3.	develop and present report effectively as member/ leader of the team on the optimal usage of resources at individual or group level using modern tools.	5, 9, 10	-
4.	demonstrate the adoption of ethics and lifelong practice of learning, the role and responsibility towards the environment as an engineering professional.	8, 12	-

Module-1	**06 Hrs.**
Environment: Definition, Eco system – components of ecosystem, Balanced eco system. Impact of human activities on environment – Agriculture – Housing – Industry – Mining and Transportation.	
Module -2	**06 Hrs.**
Environmental Pollution: Water pollution-, Air pollution – Land pollution- Noise Pollution.	
Module -3	**07 Hrs.**
Global Environmental Issues: Water & Waste Water Management. Climate change and Global Warming, Acid rain & Ozone layer depletion: controlling measures. Land Management, Solid Waste Management, E – Waste Management & Biomedical Waste Management – Sources, Characteristics & Disposal methods, Population Growth, Urbanization.	
Module-4	**07 Hrs.**
Environmental Protection- Legal aspects: Environmental impact assessment and sustainable development. Environmental Acts & Regulations- Water act and Air act. Role of government and Nongovernmental Organizations (NGOs) , Environmental Education & Women Education.	

Textbooks:

1. R Rajagopalan, "Environmental Studies – From Crisis to Cure", Oxford University Press, 2005.
2. S.M. Prakash "Environmental Studies" Elite publishers, Mangalore. 2007

Reference Books :

1. Benny Joseph "Environmental Studies" Tata Mc Graw hill
2. P. Venugopala Rao "Principles of Environmental Science and Engineering" Prentice hall of India.
3. P. Meenakshi "Elements of Environmental Science and Engineering" Prentice hall of India Private Limited, New Delhi, 2006
4. Erach Bharucha, "Text Book of Environmental Studies", for UGC, University press, 2005

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Course Title	**Analytical Ability and Soft Skills**		
Course Code	**21ASK**	**L-T-P**	**0-1-0-1**
Exam	**1**	**Hours/Week**	**40**
SEE	**50Marks**	**Total Hours**	**80**

This course will be conducted at the end of fifth semester for two weeks by TAP department. Course Objective: To Enhance problem solving skills and communication skills
Course out comes: At the end of course, student will be able to:

MODULE–1

Hard Skills: Speed/Distance, Probability, Permutations/Combinations, Profit/Loss,SimpleInterest/CompoundInterest,Numbertheories,Number/Letterseries,Coding/Decoding, Bloodrelations,

Directions, Clock, Calendar. Logic alreasoning problems

MODULE–2

Soft Skills: Basicgrammar, Spottingerrors, Sentence formation, Email writing, Publicspeaking, Client

communication, Leadership, Managerial skills, Stress management, Presentation Skills

MODULE-3

Technical Skills: Review of Cprogramming, Simple coding, Syntaxrules, MCQ son Clanguage.

MODULE-4

Activities: GD, JAM, MockInterview, Pickandspeak,Presentation