	POOJYA DODDAPPA APPA COLLEGE OF ENGINEERING, KALABURAGI Choice Based Credit System (CBCS) Scheme of Teaching and Examination AY 2023 – 24 - (Effective from the academic year 2021 – 22)													
	V Semester													
Sl. No.	**Course and Course Code**		**Course Title**	**Teaching Department**	**Teaching Hours/Week**				**Examination**				**Credits**
					Theory Lecture	**Tutorial**	**Practical /Drawing**	**Self Study**	**Duration in hours**	**CIE Marks**	**SEE Marks**	**Total Marks**	
1.	HSMC	21HU51	Entrepreneurship, Management and Finance	Humanities Dept.	3	0	0		03	50	50	100	3
2.	IPCC	21ME52	Manufacturing Process	Respective Dept.	3	0	2		03	50	50	100	4
3.	PC	21ME53	Design of Machine Elements-I		2	2	0		03	50	50	100	3
4.	PC	21ME54	Internal Combustion Engine		3	0	0		03	50	50	100	3
5.	PCL	21MEL55	Fuel and Engines Testing Lab		0	0	2		03	50	50	100	1
6.	AEC	21RMI56	Research Methodology and IPR		2	0	0		03	50	50	100	2
7.	HSMS	21CIV57	Environmental Studies	Mech	0	2	0		02	50	50	100	1
8.	AEC	21MEAE584	Information and Communication Technology(ICT)	Respective Dept.	0	2	0		02	50	50	100	1
Total					**13**	**06**	**04**			**400**	**400**	**800**	**18**

Ability Enhancement Course					
Sl. No.	Course code	Course Title	Sl. No.	Course code	Course Title
1.	21MEAE581	Basics of Matlab [0-0-2]	3	21MEAE583	Introduction to Augmented Reality [0-2-0]
2.	21MEAE582	Entrepreneurship Development (ED)[0-2-0]	4	21MEAE584	Information and Communication Technology (ICT) [0-2-0]

POOJYA DODDAPPA APPA COLLEGE OF ENGINEERING, KALABURAGI
Choice Based Credit System (CBCS)
Scheme of Teaching and Examination 2023 – 24
(Effective from the academic year 2021 – 22)

VI Semester

Sl. No.	Course and Course Code		Course Title	Teaching Department	Teaching Hours/Week				Examination				Credits
					Theory Lecture	Tutorial	Practical/ Drawing	Self Study	Duration in hours	CIE Marks	SEE Marks	Total Marks	
1.	PC	21ME61	Operations Research	Respective Dept.	3	0	0		03	50	50	100	3
2.	IPCC	21ME62	Heat and Mass Transfer	Respective Dept.	3	0	2		03	50	50	100	4
3.	PC	21ME63	Design of Machine Element-II		2	2	0		03	50	50	100	3
4.	PEC	21ME64X	Professional Elective-I		3	0	0		03	50	50	100	3
5.	OEC	21ME65OEX	Open Elective – I		3	0	0		03	50	50	100	3
6.	PCCL	21MEL66	Computer Aided Drafting (CAD) Lab		0	0	2		03	50	50	100	1
7.	MP	21MEMP67	Mini Project		Two contact hours /week for interaction between the faculty and student					50		50	2
8.	INT	21INT68	Innovation/Entrepreneurship /Societal Internship		Completed during the intervening period of IV and V semesters.					50		50	3
				Total:						**400**	**300**	**700**	**22**

Professional Elective – I		
Sl.No.	**Course code**	**Course Title**
1.	21ME641	Refrigeration and Air Conditioning
2.	21ME642	Hydraulics and Pneumatics
3.	21ME643	Machine Tool design
4.	21ME644	Robotics and Robot Applications
5.	21ME645	Operation Management

Open Elective – I		
Sl.No.	Course code	Course Title
1.	21ME65OE1	Industrial Management and Ergonomics

ENTREPRENEURSHIP, MANAGEMENT AND FINANCE				
Subject Code	21HU51	Credits	03	CIE: 50
Number of Lecture Hours/Week	3(Theory)			SEE: 50
Total Number of Lecture Hours	42			SEE Hours: 03

Prerequisite :

Course Objectives :

To enable the students to obtain the basic knowledge about Entrepreneurship and Management and finance in the following topics:-

- The Meaning, Functions, Characteristics, Types, Role and Barriers of Entrepreneurship,. Government Support for Entrepreneurship
- Management – Meaning, nature, characteristics, scope , functions, role etc and Engineers social responsibility and ethics
- Preparation of Project and Source of Finance
- Fundamentals of Financial Accounting
- Personnel and Material Management, Inventory Control

Modules	Teaching Hours
Module –I ENTREPRENEUR : Meaning of Entrepreneur; Functions of an Entrepreneur; Characteristics of an entrepreneur , Types of Entrepreneur; Intrapreneurs – an emerging class ; Role of Entrepreneurs in economic development; Barriers to entrepreneurship, Government Support for Innovation and Entrepreneurship in India - Startup-India, Make-in-India, PMMY, AIM , STEP, BIRAC, Stand-up India, TREAD	**8 Hours**
Module –II MANAGEMENT: Introduction – Meaning – nature and characteristics of Management, Scope and functional areas of management, Levels of Management, Henry Fayol - 14 Principles to Management , McKinsey's 7-S Model, Management by objective(MBO) – Meaning, process of MBO, benefits and drawbacks of MBO.	**8 Hours**
Module –III PREPARATION OF PROJECT AND SOURCE OF FINANCE: PREPARATION OF PROJECT: Meaning of project; Project Identification; Project Selection; Project Report; Need and Significance of Report; Contents; SOURCE OF FINANCE: Long Term Sources(Equity, Preference, Debt Capital, Debentures, loan from Financial Institutions etc) and Short Term Source(Loan from commercial banks, Trade Credit, Customer Advances etc)	**8 Hours**
Module –IV FUNDAMENTALS OF FINANCIAL ACCOUNTING: Definition, Scope and Functions of Accounting , Accounting Concepts and Conventions: Golden rules of Accounting, Final Accounts - Trading and Profit and Loss Account, Balance sheet	**9 Hours**

Module –V	9 Hours
PERSONNEL MANAGEMENT, MATERIAL MANAGEMENT AND INVENTORY CONTROL: PERSONNEL MANAGEMENT: Functions of Personnel Management, Recruitment, Selection and Training, Wages, Salary and Incentives MATERIAL MANAGEMENT AND INVENTORY CONTROL: Meaning, Scope and Objects of Material Management. Inventory Control- Meaning and Functions of Inventory control ; Economic Order Quantity(EOQ) and various stock level (Re-order level, Minimum level, Maximum level, Average level and Danger level)	

Question paper pattern:

1. Total of Ten Questions with two from each MODULE to be set covering the entire syllabus.
2. Five full questions are to be answered choosing at least one from each MODULE.
3. Each question should not have more than 3 sub divisions.

Text books:

1.Financial Accounting -B S RAMAN- United Publishers Manglore, Maheswar S N & Maheswari S K-Vikas Publishing House. January 2018

2. Management & Entrepreneurship- K R Phaneesh- Sudha Publications January 2018 ,Prof Manjunatha & Amit kumar G – laxmi Publication , January 2011. Veerbhadrappa Havina -Published by New Age International (P) Ltd., 2009.

3. Principles of Management First Edition (English, G. Murugesan), Laxmi Publications – New Delhi

4. Management by Objectives (Mbo) in Enterprises: 21 December 2018 by Dr Wazir Ali Khan

Reference Books:

1) Industrial Organization & Engineering Economics-T R Banga & S C Sharma- Khanna Publishers, Dehli.

NPTEL : ENTREPRENEURSHIP: PROF. C BHAKTAVATSALA RAO Department of Management Studies IIT Madras https://nptel.ac.in/courses/110/106/110106141/

https://www.businessmanagementideas.com/notes/management-notes/notes-on-management-in-an-organisation/4669

https://vskub.ac.in/wp-content/uploads/2020/04/Unit-5-ppmb.pdf

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

CO	Course Outcomes
CO1	Develop Entrepreneurship skills
CO2	Apply the concepts of management and Management By Objective(MBO)
CO3	Prepare project report & choose different Source of Finance.
CO4	Apply Fundamentals of Financial Accounting and interpret the final accounts
CO5	Apply personnel management skills, Material and inventory control techniques

Note: CIE FOR 03 CREDIT PROFESSIONAL CORE COURSE

The CIE theory component constitutes of

- CIE IA Test with maximum 25 marks and minimum passing 10 marks
- CIE CCAs with maximum 25 marks and minimum passing 10 marks
- There shall be three Continuous Internal Evaluations (CIE) for the courses with 03 credits.
- The CIE Question paper shall be set for a maximum of 30 marks with questions having a maximum of three bits.

The question needs to be framed covering the entire syllabus (33%) completed before the consecutive CIEs.

The cumulative marks of the three CIE is to be divided by 3.6 to reduce the final CIE marks to a maximum of 25 marks and the minimum passing mark for this is 10.

Another 25 marks are dedicated to other assessment tools with suitable weightage for each, that include quizzes, assignments, mini-projects, presentations, case studies, surveys, group discussions, slip tests, etc, and the minimum passing mark for this is 10 (If the assessment is mini-project based then only one assessment method may be adopted or otherwise, any two assessment tools may be used.

SEMESTER END EXAMINATION (SEE):

Theory SEE will be conducted by scheduled timetable, with question papers for the subject (duration 03 hours).

The question paper shall be set for 100 marks.

- The duration of SEE is 03 hours. The question paper will have 10 questions. Two questions per module. Each question is set for 20 marks.
- Students have to answer 5 full questions, selecting one full question from each module.
  The student has to answer for 100 marks and marks scored out of 100 shall be proportionally reduced to 50 marks.
- There will be 2 questions from each module. Each of the two questions under a module

MANUFACTURING PROCESSES				
Subject Code	21ME52	Credits	04	CIE: 50
Number of Lecture Hours/Week	3(Theory) + 2(Practical)			SEE: 50
Total Number of Lecture Hours	42			SEE Hours: 03

Prerequisite :

Course Objectives:

1. Understand the foundry practice
2. Examine plastic deformation and understand metal forming methods
3. Gain insight into the principle of fusion and plastic welding processes and learn newer welding processes
4. Learn to analyze cutting forces and construct merchant circle diagram.
5. Understand the working of continuous and intermittent cutting machine tools and their operations

Modules	Teaching Hours
Module –I Introduction to manufacturing processs – Primary and secondary manufacturing processes. Foundry :pattern types, allowances, molding sands & their properties, cores. Element of gating system. shell moulding, die casting.	**8 Hours**
Module –II Metal forming : Hot and cold working – Rolling, forging and extrusion processes. Explosive forming and electro – hydraulic forming. Powder metallurgy.	**8 Hours**
Module –III Welding processes : Gas welding : Oxy acetylene gas welding process, Flame characteristics. Arc welding manual metal arc welding, arc cutting . Resistance welding: Spot & seam welding processes. Electron beam and laser beam welding processes.	**8 Hours**
Module –IV Metal cutting : Tool nomenclature , Tool materials, Taylor's tool life, Orthogonal & Oblique cutting, Mechanism of chip formation , Type of chips. Shear angle equation, Cutting forces, merchant circle diagram – Simple problems	**9 Hours**
Module –V Machine tools: Lathe, drilling, milling, shaper – Working principle and operations. Surface finishing processes: Grinding, honing, lapping. Calculation of machining time in Shaper, Lathe and drilling machines.	**9 Hours**

Question paper pattern:

1. Total of Ten Questions with two from each MODULE to be set covering the entire syllabus.
2. Five full questions are to be answered choosing at least one from each MODULE.
3. Each question should not have more than 3 sub divisions.

Text books:

1. Elements of workshop technology – S.K and A.K Hajra Choudary Vol 1 and Vol 2 Publisher: Media promoters and publishers Pvt ltd.

Reference Books:

1. Manufacturing Technology :- R.K Rajput Publisher : Laxmi prabhications pvt ltd. (LP)

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

CO	Course Outcomes
CO1	Able & understand foundry practice and gating system.
CO2	Gain knowledge of metal forming and plastic deformation
CO3	Recognize the importance of fusion and plastic welding processes
CO4	Analyze the cutting forces and verify graphically.
CO5	Understand the working of various machine tools and their operations.

MANUFACTURING PROCESSES LABORATORY-II

Course Objectives:

1. To gain hands on experience of foundry practice and moulding sand testing.
2. To understand different forming methods and prepare a forging model.
3. To provide insight into different machine tools and their operations and prepare model.

Modules

PART-I

Foundry and Forging : Demonstration of moulding procedure . Testing of moulding sand: compression, Shear and tensile tests, permeability test, Clay content test, Moisture content test, Mould hardness test.

PART-II

Machine tools : Lathe : turning, facing, taper turning, chamfering, knurling – 1 model
Shaper: Key way cutting - 1 model.
Milling: Gear cutting - 1 model
Grinding: Surface grinding – 1 model.

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

CO	Course Outcomes
CO1	Describe the importance of primary manufacturing processes.
CO2	Recognize of sizing and shaping of metallic materials by chip less machining processes, defects in manufactured components and their remedies.
CO3	Apply the Skill to fabricate simple parts and test them.
CO4	Create and practically understand the moulding procedure and different moulding processes.
CO5	Analyze the melting practice and to perform various sand testings and also recognize the importance of fusion welding and special welding techniques .

CIE AND SEE FOR THE INTEGRATED PROFESSIONAL CORE COURSE (IPCC) WITH 4 CREDITS (L-T-P: 3-0-2)

a) CIE THEORY COMPONENT

The CIE theory component constitutes of

- CIE - Internal Assessment Test with maximum 15 marks with minimum passing 6 marks
- CIE - Continuous and Comprehensive Assessment with maximum 10 marks with minimum passing 4 marks

There shall be three Continuous Internal Evaluations (CIE)

- The CIE Question paper shall be set for a maximum of 30 marks with questions having a maximum of three bits.
- The question needs to be framed covering the entire syllabus (33%) completed before the consecutive CIEs.
- The cumulative marks of the three CIE is to be divided by 6 to reduce the final CIE marks to a maximum of 15 marks and the minimum passing mark for this is 6.
- Another 10 marks are dedicated to other assessment tools with suitable weightage for each, that include quizzes, assignments, mini-projects, presentations, case studies, surveys, group discussions, slip tests, etc, and the minimum passing mark for this is 4. (If the assessment is mini-project based then only one assessment method may be adopted or otherwise, any two assessment tools may be used.
- The laboratory component of the IPCC shall be for CIE only no SEE.

b) CIE PRACTICAL COMPONENT

The CIE practical component constitutes of

- CIE Practical with maximum 15 marks and minimum passing 6 marks
- CIE Practical Test with maximum 10 marks and minimum passing 4 marks
- The maximum marks dedicated for conducting the experiments and preparation of laboratory records is 15 with minimum passing marks 6.
- The final CIE practical test for 50 marks to be conducted after completion of all the experiments and the scored marks is reduced to the maximum of 10 with minimum passing marks 4.

The maximum marks for both CIE theory and Practical is 50 and minimum passing marks is 20

DESIGN OF MACHINE ELEMENTS-I			
Subject Code	**21ME53**	**Credits: 03**	**CIE: 50**
Number of Lecture Hours/Week	**2 (Theory) + 2(Tutorial)**		**SEE: 50**
Total Number of Lecture Hours	**42**		**SEE Hours: 03**

PREREQUISITE: 1) Mathematical methods such as Differentiation, Integration, Linear differential equations, Geometry of plane surfaces 2) Physics: Units and dimensions, 3) Mechanics of materials: Stress, strain, Elastic constants, Types of loads, Centre of gravity and Moment of inertia of basic planes, Resolution of forces.

COURSE OBJECTIVES:

1. To introduce to codes and standards, safe design practices, different types of stresses and computation of tensile and compressive stresses for the given static load conditions on machine elements.
2. To be able to compute the stress concentration at different types of stress raisers for different types of load conditions and to design the machine elements subjected fatigue loading.
3. To be able to select suitable mechanical joints, couplings, keys for given load conditions and design economical and safe shafts, keys and couplings for the given operating conditions.
4. To design the suitable power transmission system using belts and pulleys and power screws based on the specified operating conditions.
5. To be able to design suitable brakes and clutches from safety and economy considerations for the given service conditions.

Modules	Teaching Hours
Module-I **INTRODUCTION**: Stages of design Codes and Standards in Design, Properties of engineering materials, Factor of safety, Stress – Strain relationship for ductile and brittle materials **DESIGN AGAINST STATIC LOAD:** Principal stresses, Modes of failure, Theories of failure, Calculate the magnitude of maximum tensile and compressive stresses at the extreme fibers in the machine elements subjected to static loading (For square, rectangle, circular cross sections only, hollow and solid sections)	**6 Hours**
Module-II **STRESS CONCENTRATION:** Causes for Stress concentration, Methods to mitigate the effect of stress concentration. Stress concentration factors, Notch sensitivity, Estimating the stress concentration at various stress raisers for different load conditions, Deciding the dimensions for safety and safe load carrying capacity. **DESIGN AGAINST FLUCTUATING LOAD:** Fluctuating stresses, Fatigue failure, Endurance limit, Design for finite and infinite life (for combination of maximum two types of loads), Soderberg's and Goodman criteria..	**6 Hours**

Module-III **MECHANICAL JOINTS:** Riveted joints advantages and disadvantages, Failure of riveted joints, Design of riveted joints for given arrangement of rivets and load conditions. Welded joints, Finding the depth of weld depending upon the array and load conditions, Screwed joints (For only Eccentric loading of above joints) **SHAFTS, KEYS AND COUPLINGS:** Design of shafts for the cases of simple loading, Design against static load, Strength and rigidity design, Types of keys, Design of square and flat keys, Design of Rigid and flexible couplings for given load and speed conditions.	**8 Hours**
Module-IV **BELTS:** Flat Belts, Ratio of belt tensions with and without centrifugal tension, Slip, Creep, Initial Belt tension, Design of belt drive for given speed, center distance and material of belt, V-Belts : Construction, Advantages and disadvantages, Ratio of belt tensions, Design of V-belt drive for given power and speed conditions. **POWER SCREWS:** Forms of threads, Square threads, Trapezoidal threads, Stresses in screw, Torque required to raise and lower the load, Efficiency, Self locking and overhauling conditions, Design of Screw jack to lift the given load through required height.	**8 Hours**
Module V **BRAKES:** Necessity for brakes, Design of Block Brakes, Simple and Differential Band Brakes, Band and Block Brakes for given operating conditions. **CLUTCHES:** Function of clutch, Uniform pressure and Uniform wear theories, Torque transmitted by the single plate clutch, Design of Single plate and Multi plate clutches, Design of Cone clutch. Calculation of Force required for engaging the clutch and finding the dimensions of the plates.	**6 Hours**

Question paper pattern:

1.Total of Ten Questions with Two questions from each Module to be set covering the entire syllabus.

2.Five full questions are to be answered selecting at least One full question from each Module.

3.Each question should not have more than 3 sub divisions.

Text books:

1. Design of Machine Elements By V B Bhandari, McGraw Hill
2. Machine Design By R S Khurmi, S. Chand Publications

Reference Books:

1. Mechanical Engineering Design By Shigley & Mische, McGraw Hill

2. Machine Design By Black & Adams, McGraw Hill

Course outcomes:

On completion of the course, the student will have the ability to:

CO #	Course Outcome (CO)
CO1	Use codes and standards for machine elements and to design the machine elements subjected to compound stresses.
CO2	Investigate stress concentration factor depending upon the type of stress raiser and loading and to design the elements subjected to fluctuating loads
CO3	Design mechanical joints and different types of couplings along with shaft and key as per the given
CO4	Design suitable belt drives and power screws to transmit power under given conditions.
CO5	Design suitable brakes and clutches for the given conditions

Note: CIE FOR 03 CREDIT PROFESSIONAL CORE COURSE

The CIE theory component constitutes of

- CIE IA Test with maximum 25 marks and minimum passing 10 marks
- CIE CCAs with maximum 25 marks and minimum passing 10 marks
- There shall be three Continuous Internal Evaluations (CIE) for the courses with 03 credits.
- The CIE Question paper shall be set for a maximum of 30 marks with questions having a maximum of three bits.

The question needs to be framed covering the entire syllabus (33%) completed before the consecutive CIEs.

The cumulative marks of the three CIE is to be divided by 3.6 to reduce the final CIE marks to a maximum of 25 marks and the minimum passing mark for this is 10.

Another 25 marks are dedicated to other assessment tools with suitable weightage for each, that include quizzes, assignments, mini-projects, presentations, case studies, surveys, group discussions, slip tests, etc, and the minimum passing mark for this is 10 (If the assessment is mini-project based then only one assessment method may be adopted or otherwise, any two assessment tools may be used.

SEMESTER END EXAMINATION (SEE):

Theory SEE will be conducted by scheduled timetable, with question papers for the subject (duration 03 hours).

The question paper shall be set for 100 marks.

- The duration of SEE is 03 hours. The question paper will have 10 questions. Two questions per module. Each question is set for 20 marks.
- Students have to answer 5 full questions, selecting one full question from each module.
- The student has to answer for 100 marks and marks scored out of 100 shall be proportionally reduced to 50 marks.
- There will be 2 questions from each module. Each of the two questions under a module

INTERNAL COMBUSTION ENGINES			
Subject Code	**21ME54**	**Credits: 03**	**CIE: 50**
Number of Lecture Hours/Week	**3 (Theory)**		**SEE: 50**
Total Number of Lecture Hours	**42**		**SEE Hours: 03**

PREREQUISITE: Thermodynamics, Fluid Mechanics

COURSE OBJECTIVES:

1. Different types of internal combustion engines and the parameters that define engine performance and analyze performance and efficiency aspects.
2. Importance fuel-air mixture preparation processes and fuel supply system in
3. gasoline and diesel engines.
4. Spark-ignition (SI) and compression ignition (CI) engine combustion, SI and CI engine knock, and combustion chambers.
5. Overall engine operating characteristics: supercharging, turbo-charging, variable valve-timing, gasoline direct injection, multi fuel and dual fuel engine.

Modules	Teaching Hours
Module-I **INTRODUCTION TO I.C. ENGINES:** Introduction, Basic engine components, Classification of I.C. Engines. Valve timing diagram for high & low speed engine, Port timing diagram. **FUEL AIR CYCLES:** Fuel Air Cycles ,Variations in specific heat, Dissociation, Simple problems.	**8 Hours**
Module-II **FUEL SYSTEMS FOR S.I. ENGINES:** Elementary and Complete carburetor Derivation for calculation of A/F ratio. Multi Point Fuel injection system (MPFI) (Numerical on calculations of main dimension of carburetor). **COMBUSTION IN S. I. ENGINES:** Stages of combustion, Ignition lag, Flame propagation, Factors affecting flame speed, abnormal combustion, operating variables on detonation, Requirements of combustion chambers of S.I. Engines and its types.	**9Hours**
Module-III **REQUIREMENTS OF INJECTION SYSTEM:** Fuel metering, pressurizing and injecting system, Types of. System- Individual pump, Common rail and Distributor systems, Unit injector, Types of fuel nozzles, Governing of CI Engines, Pneumatic governors. **COMBUSTION IN C.I. ENGINES:** Stages of combustion, Delay period, Factors affecting delay period, Abnormal combustion-Diesel knock, operating variables on diesel knock, Comparison of abnormal combustion in S I and C I engines, Requirements of combustion chambers for C.I. engines and its types.	**8 Hours**
Module-IV **SUPERCHARGING:** Purpose of supercharging, Thermodynamic cycle of supercharged engine, Types of superchargers, Turbo charging, Advantages and disadvantages, Limits of supercharging for S.I. and C.I. Engines. **PERFORMANCE AND TESTING OF ENGINES:** Performance parameters, determination of IP, BP, FP, Mean effective pressure, Fuel consumption, Air Consumption, Engine efficiencies, Performance characteristics, Energy balance.	**9 Hours**

Module V	
ALTERNATIVE FUELS FOR I C ENGINES: Ethanol,Methanol, Hydrogen,Natural Gas, LPG,CNG,DME,DEE,Bio gas and Bio-diesel,Properties,advantages and disadvantages. **ENGINE EMISSION AND CONTROL:** S.I. engine emission (HC, CO, NOx) Control methods- Evaporative (ELCD), Thermal, Catalytic converters, C.I. Engines Emission (CO, NOx, Smog, Particulate), Control methods- EGR.	**9 Hours**

Question paper pattern:

1. Total of Ten Questions with Two questions from each Module to be set covering the entire syllabus.
2. Five full questions are to be answered selecting at least One full question from each Module.
3. Each question

Text books:

1. Internal Combustion Engines, V. Ganesan, Tata Mc-Graw Hill Publications, 4th Edition, 2012.
2. Internal Combustion Engines, M. L. Mathur and R. P. Sharma, DhanpatRai Publications, 2014.

Reference Books:

1. Internal Combustion Engine Fundamentals, John B. Heywood, Mc-Graw Hill Education India Limited, 2011.
2. Engineering Fundamentals of the Internal Combustion Engines, Willard W. Pulkrabek. Pearson Education, 2nd Edition, 2015.
3. A Text Book of Internal Combustion Engines, R.K. Rajput, Laxmi Publishers, 2007.

Course outcomes:
On completion of the course, the student will have the ability to:

CO #	Course Outcome (CO)
CO1	Able to apply knowledge of basic I C Engine and cycles of operation.
CO2	Able to apply effectively the various types carburetors and combustion phenomena in SI engines.
CO3	Interpret fuel supply systems and combustion processes in CI Engines
CO4	To evaluate Basic performance parameters of I.C.Engine and study the supercharging.
CO5	Examine different alternative fuels for IC Engines and Students can effectively contribute towards reduction in emission which has a severe impact on the environment.

Note: CIE FOR 03 CREDIT PROFESSIONAL CORE COURSE

The CIE theory component constitutes of

- CIE IA Test with maximum 25 marks and minimum passing 10 marks
- CIE CCAs with maximum 25 marks and minimum passing 10 marks
- There shall be three Continuous Internal Evaluations (CIE) for the courses with 03 credits.
- The CIE Question paper shall be set for a maximum of 30 marks with questions having a maximum of three bits.

The question needs to be framed covering the entire syllabus (33%) completed before the consecutive CIEs.

The cumulative marks of the three CIE is to be divided by 3.6 to reduce the final CIE marks to a maximum of 25 marks and the minimum passing mark for this is 10.

Another 25 marks are dedicated to other assessment tools with suitable weightage for each, that include quizzes, assignments, mini-projects, presentations, case studies, surveys, group discussions, slip tests, etc, and the minimum passing mark for this is 10 (If the assessment is mini-project based then only one assessment method may be adopted or otherwise, any two assessment tools may be used.

SEMESTER END EXAMINATION (SEE):

Theory SEE will be conducted by scheduled timetable, with question papers for the subject (duration 03 hours).

The question paper shall be set for 100 marks.

- The duration of SEE is 03 hours. The question paper will have 10 questions. Two questions per module. Each question is set for 20 marks.
- Students have to answer 5 full questions, selecting one full question from each module.
- The student has to answer for 100 marks and marks scored out of 100 shall be proportionally reduced to 50 marks.
- There will be 2 questions from each module. Each of the two questions under a module

FUEL AND ENGINES TESTING LAB			
Subject Code	**21MEL55**	**Credits: 01**	**CIE: 50**
Number of Lecture Hours/Week	**2 (Practical)**		**SEE: 50**
Total Number of Lecture Hours	**28**		**SEE Hours: 03**

PREREQUISITE:

1. The student should know the fundamentals of IC Engines
2. Should aware of performance, emission and combustion terms.
3. Should have profound knowledge of instruments**.**

COURSE OBJECTIVES:

1. To describe the performance and operating characteristics of Internal Combustion Engines
2. To explain the parts and complete knowledge of type of fuels used in IC engines and the fuel supply systems.
3. To describe combustion process phenomena in IC engines.
4. To explain the different methods of performance analysis of IC engines.
5. To explain the effects of exhaust emission on human health and different pollution norms

Modules

Module-I

(Group Experiments)

Performance tests on I C Engines:

Calculations of IP, BP, Thermal efficiencies, SFC, FP, heat balance sheet for

1. Four stroke Diesel Engine
2. Four stroke Petrol Engine
3. Multi-cylinder Diesel/Petrol Engine (Morse Test)
4. Variable Compression Ratio I C Engine.

Module-II

(Individual Experiments)

Fuels and Lubricants Testing:

1. Determination of Flash point and Fire point of lubricating oil using Abel apparatus and Pensky Martin apparatus.
2. Determination of Calorific value of solid, liquid and gaseous fuels.
3. Determination of Viscosity of a lubricating oil using Redwoods, Saybolts, Torsion Viscometers.
4. Valve, Timing/ port opening diagram of an I C Engine (4 stroke/ 2 stroke).

SCHEME OF EXAMINATION:

1.One Model from Module I 20 Marks

2.One Model from Module II 20 Marks

3.Viva voce 10 Marks

Course outcomes:
On completion of the course, the student will have the ability to:

CO #	Course Outcome (CO)
CO1	Understand the complete operation of 2 stroke and 4 stroke I.C.Engines
CO2	Find the performance of 2-S and 4-S engines and the variation of various performance parameters with load and speed.
CO3	Know how to balance the heat energy available in engine cylinder after the combustion process
CO4	Analyze the performance of the variable compression ratio engine
CO5	Find the kinematic viscosity of fuels and its variation with temperature.

CIE FOR THE COURSES WITH 01 CREDIT:

CIE FOR THE LABORATORY COURSE

- Maximum of 30 marks is allotted for Practical CIE (Continuous Internal Evaluation) for conduction of experiments and preparation of laboratory records etc with minimum passing marks 12.
- The test after all experiments conducted for 50 Marks needs to be reduced to 20 and the minimum passing mark is 08.
- Maximum of 50 marks is allotted for the practical SEE with minimum passing marks 20.

RESEARCH METHODOLOGY & INTELLECTUAL PROPERTY RIGHTS			
Subject Code	21RMI56	**Credits: 02**	CIE: 50
Number of Lecture Hours/Week	2(Theory)		SEE: 50
Total Number of Lecture Hours	28		SEE Hours: 03

Prerequisite : Nil

Course Objectives:

1: To Understand the knowledge on basics of research and its types.
2: To Learn the concept of defining research problem and Literature Review,Technical Reading.
3: To learn the concept of attributions and citation and research design.
4: Concepts, classification, need for protection, International regime of IPRs - WIPO , TRIPS, Patent - Meaning, Types, surrender, revocation, restoration, Infringement , Procedure for obtaining Patent and Patent Agents.
5: Meaning, essential requirements, procedure for registration and Infringement of Industrial Designs, Copyright.

Modules	Teaching Hours
Module –I Introduction: Meaning of Research, Objectives of Engineering Research, and Motivation in Engineering Research, Types of Engineering Research, Finding and Solving a Worthwhile Problem. Ethics in Engineering Research, Ethics in Engineering Research Practice, Types of Research Misconduct, Ethical Issues Related to Authorship.	**06 Hours**
Module –II **Defining the research problem** - Selecting the problem. Necessity of defining the problem Techniques involved in defining the problem- Importance of literature review in defining a problem. Literature Review and Technical Reading, New and Existing Knowledge, Analysis and Synthesis of Prior Art Bibliographic Databases, Web of Science, Google and Google Scholar, Effective Search: The Way Forward Introduction to Technical Reading Conceptualizing Research, Critical and Creative Reading, Taking Notes While Reading, Reading Mathematics and Algorithms, Reading a Datasheet.	**06 Hours**
Module –III **Research design and methods** - Research design - Basic principles. Need of research design Features of good design- Important concepts relating to research design - Observation and Facts. **Attributions and Citations:** Giving Credit Wherever Due, Citations: Functions and Attributes, Impact of Title and Keywords on Citations, Knowledge Flow through Citation, Citing Datasets, Styles for Citations, Acknowledgments and Attributions, What Should Be Acknowledged, Acknowledgments in, Books Dissertations, Dedication or Acknowledgments.	**06 Hours**

Module –IV Basic Concepts of Intellectual Property (IP), Classification of IP, Need for Protection of IP, International regime of IPRs - WIPO , TRIPS. **Patents:** Meaning of a Patent – Characteristics/ Features . Patentable and Non-Patentable Invention. Procedure for obtaining Patent. Surrender of Patent, revocation &restoration of Patents, Infringement of Patents and related remedies (penalties) . Different prescribed forms used in Patent Act. Patent agentsqualifications and disqualifications Case studies on patents - Case study of Neem petent, Curcuma(Turmeric)patent and Basmati rice patent, Apple inc.v Samsung electronics co.Ltd.	**05 Hours**
Module –V **Industrial Design**: Introduction to Industrial Designs. Essential requirements of Registration. Designs which are not registrable, who is entitled to seek Registration, Procedure for Registration of Designs. **Copy Right** Meaning of Copy Right. Characteristics of Copyright. Who is Author, various rights of owner of Copyright. Procedure for registration. Term of copyright, Infringement of Copyright and Its remedies. Software Copyright.	**05 Hours**

Text books:

1. Research Methodology: Methods and Techniques C.R.Kothari, Gaurav Garg New Age International 4thEdition,2018
2. Dipankar Deb•RajeebDey,ValentinaE.Balas "EngineeringResearchMethodology",ISSN1868- 4394 ISSN 1868-4408 (electronic), Intelligent Systems Reference Library, ISBN 978-981-13- 2946-3 ISBN 978-981-13-2947-0 (eBook), https://doi.org/10.1007/978-981-13-2947-0.3.
3. . Dr. M.K. Bhandari"Law relating to Intellectual property" January 2017 (Publisher By Central Law Publications).
4. Dr. R Radha Krishna and Dr. S Balasubramanain "Text book of Intellectual Property Right". First edition, New Delhi 2008. Excel books.
5. P Narayan "Text book of Intellectual Property Right". 2017 ,Publisher: Eastern Law House.

Reference Books:

1. DavidV.Thiel"ResearchMethodsforEngineers"CambridgeUniversityPress,978-1-107-03488- 4-
2. Nishith Desai Associates - Intellectual property law in India – Legal, Regulatory & Tax

NPTEL:
INTELLECTUAL PROPERTY by PROF.FEROZ ALI , Department of Humanities and Social Sciences IIT Madras https://nptel.ac.in/content/syllabus_pdf/109106137.pdf
www.wipo.int
www.ipindia.nic.in

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

CO	Course Outcomes
CO1	To know them leaning of engineering research.
CO2	To know the defining of research problem and procedure of Literature Review.
CO3	To know the Attributions and Citations and research design.
CO4	Highlights the basic Concepts and types of IPRs and Patents
CO5	Analyse and verify the procedure for Registration of Industrial Designs & Copyrights.

Assessment Details (both CIE and SEE)

The weight age of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 35% (18 Marks out of 50) in the semester end examination (SEE), and a minimum of 40% (40 marks out of 100) in the sum total of the CIE(Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:
Three Unit Tests each of 20 Marks (duration 01hour)

1. First test at the end of 5th week of the semester
2. Second test at the end of the 10th week of the semester
3. Third test at the end of the15th week of the semester

Two assignments each of 10 Marks

4. First assignment at the end of 4th week of the semester
5. Second assignment at the end of 9th week of the semester Group discussion/ Seminar/quiz any one of three suitably planned to attain the Cos and Pos for 20 Marks (duration 01 hours)
6. At the end of the 13th week of the semester.

The sum of three tests, two assignments, and quiz/seminar/group discussion will be out of 100 marks and will be **scaled down to 50marks** (to have less stressed CIE, the portion of the syllabus should not be common /repeated for any of the methods of the CIE. Each method of CIE should have a different syllabus portion of the course). CIE methods/question paper is designed to attain the different levels of Bloom's taxonomy as per the Outcome defined for the course.

ENVIRONMENTAL STUDIES			
Subject Code	21CIV57	**Credits: 01**	CIE: 50
Number of Lecture Hours/Week	2(Tutorial)		SEE: 50
Total Number of Lecture Hours	28		SEE Hours: 01

Prerequisite : Nil

Course Objectives:

To create environmental awareness among the students.ν

To gain knowledge on different types of pollution in the environment.ν

Teaching-Learning Process(General Instructions) These are sample Strategies; which teacher can use to accelerate the attainment of the various course outcomes.

1. Apart from conventional lecture methods various types of innovative teaching techniques through videos and animation films may be adopted so that the delivered lesson can progress the students in theoretical, applied and practical skills.
2. Environmental awareness program on off campus
3. Encourage collaborative (Group Learning) Learning in the class.Seminars, surprise tests and Quizzes may be arranged for students in respective subjects to develop skills

Modules	**Teaching Hours**
Module –I Ecosystems (Structure and Function): Forest, Desert, Wetlands, River, Oceanic and Lake. Biodiversity:Types,Value;Hot spots; Threats and Conservation of biodiversity, Forest Wealth, and Deforestation.	**05 Hours**
Module –II Advances in Energy Systems (Merits, Demerits, Global Status and Applications): Hydrogen, Solar, OTEC, Tidal and Wind. Natural Resource Management (Concept and case-studies): Disaster Management, Sustainable Mining, case studying, and Carbon Trading.	**05 Hours**
Module –III **Environmental Pollution** (Sources, Impacts, Corrective and Preventive measures, Relevant Environmental Acts, Case-studies): Surface and Ground Water Pollution; Noise pollution; Soil Pollution and Air Pollution. **Waste Management & Public Health Aspects** :Bio-medical Wastes; Solid waste; Hazardous, Wastes; E-wastes; Industrial and Municipal Sludge.	**06 Hours**
Module –IV **Global Environmental Concerns**(Concept, policies and case-studies): Groundwater depletion/recharging, Climate Change; Acid Rain; Ozone Depletion; Radon and Fluoride problem In drinking water; Resettlement and rehabilitation of people, Environmental Toxicology.	**06 Hours**

Module –V	
Latest Developments in Environmental Pollution Mitigation Tools (Concept and Applications): G.I.S. & Remote Sensing, Environment Impact Assessment, Environmental Management Systems, ISO14001; Environmental Stewardship- NGOs. Field work: Visit to an Environmental Engineering Laboratory or Green Building or Water Treatment Plant or Waste water treatment Plant; ought to be Followed by understanding of process and its brief Documentation in the form of report.	**06 Hours**

Text books:

1.Environmental studies, Benny Joseph, Tata Mcgraw -Hill 2ndedition 2012·

2. Environmental studies, SM Prakash , pristine publishing house, Mangalore3rdedition-2018.

Reference Books:

1.BennyJoseph, Environmental studies,TataMcgraw-Hill2ndedition 2009·

2.M. Ayi Reddy TextbookofenvironmentalscienceandTechnology,BSpublications2007·

3.Dr.B.SChauhan,Environmentalstudies,universityofsciencepress1stedition

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

CO	Course Outcomes
CO1	Understand the principles of ecology and environmental issues that apply to air, land, and water issues on a global scale,
CO2	Develop critical thinking and/or observation skills, and apply them to the analysis of a problem or question related to the environment.
CO3	Demonstrate ecology knowledge of a complex relationship between biotic and a biotic components.
CO4	Apply their ecological knowledge to illustrate and graph a problem and describe the realities that managers face when dealing with complex issues.
CO5	Understand Latest Developments in Environmental Pollution Mitigation Tools Concept and Applications of G.I.S. & Remote Sensing.

Continuous Internal Evaluation:

Three Unit Tests each of **20Marks (duration 01 hour)**

1. First test at the end of5th week of the semester
2. Second test a the end of the10th week of the semester
3. Third test at the end of the15thweek of the semester Two assignments each of **10 Marks**
4. First assignment at the endof4thweek of the semester
5. Second assignment at the end of 9thweek of the semester Group discussion/Seminar/quiz any one of three suitably planned to attain the Cos and Pos for **20 Marks (duration 01hours)**
6. At the end of the13thweek of the semester The sum of three tests, two assignments, and quiz/seminar/group discussion will be out of 100 marks and will be Scaled down to 50 marks

(to have less tresses CIE, the portion of the syllabus should not be common/repeated for any of the method of the CIE. Each method of CIE should have a different syllabus portion of the course).

CIE methods/question paper is designed to attain the different levels of Bloom' s taxonomy as per the outcome defined for the course.

Semester End Examination:

Theory SEE will be conducted by college as per the scheduled timetable, with common question papers for the subject (duration 01 hours) Question paper pattern:

1. The Question paper will have 50 objective questions.
2. Each question will before 01marks
3. Students will have to answer all the questions on an OMR Sheet.
4. The Duration of the Exam will be 01 hour.

Ability Enhancement Courses

Basics of MATLAB			
Subject Code	21MEAE581	Credits: 01	CIE: 50
Number of Lecture Hours/Week	02 LAB		SEE: 50
Total Number of Lecture Hours	28		SEE Hours: 03

Course objectives:

1. To know about fundamentals of MATLAB tool.
2. To provide an overview to program curve fitting & solve Linear and Nonlinear Equations.
3. To understand the concept and importance of Fourier transforms.
4. To gain knowledge about MATLAB Simulink & solve Electrical engineering problems.

Experiments

1. Introduction to MATLAB Programming: Basics of MATLAB Programming, array operations in MATLAB, loops 2 and execution of control, working with files: Scripts and functions, plotting and programming output, examples.
2. Numerical Methods and their applications: Curve Fitting: Straight line fit, Polynomial fit.
3. Numerical Integration and Differentiation: Trapezoidal method, Simpson method.
4. Linear and Nonlinear Equations: Eigen values, Eigen vectors, Solution of linear algebraic equations using Gauss Elimination and LU decomposition, Solution of nonlinear equation in single variable using Gauss-Siedal and Newton-Raphson method.
5. Ordinary Differential Equations: Introduction to ODE's, Euler's method, second order RungaKutta method, MATLAB ode45 algorithm in single variable and multivariable. Transforms: Discrete Fourier Transforms,
6. Application of MATLAB to analyze problems in basic engineering mechanics, mechanical vibrations, control system, statistics and dynamics of different circuits.
7. MATLAB Simulink: Introduction to MATLAB Simulink, Simulink libraries, development of basic models in Simscape Power Systems

Course outcomes (Course Skill Set):

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

1. Able to implement loops, branching, control instruction and functions in MATLAB programming environment.
2. Able to program curve fitting, numerical differentiation and integration, solution of linear equations in MATLAB and solve electrical engineering problems.
3. Able to understand implementation of ODE using ode 45 and execute Solutions of nonlinear equations and DFT in MATLAB.
4. Able to simulate MATLAB Simulink examples.

CIE FOR THE LABORATORY COURSE

- Maximum of 30 marks is allotted for Practical CIE (Continuous Internal Evaluation) for conduction of experiments and preparation of laboratory records etc with minimum passing marks 12.
- The test after all experiments conducted for 50 Marks needs to be reduced to 20 and the minimum passing mark is 08.
- Maximum of 50 marks is allotted for the practical SEE with minimum passing marks 20.

ENTREPRENEURSHIP DEVELOPMENT			
Subject Code	**21MEAE582**	**Credits: 01**	**CIE: 50**
Number of Lecture Hours/Week	**2 (Tutorial)**		**SEE: 50**
Total Number of Lecture Hours	**28**		**SEE Hours: 03**

PREREQUISITE: NIL

COURSE OBJECTIVES:
A Generic Course that is intended to inculcate an integrated personal Life Skill to the student.

Modules-I	**Teaching Hours**
Entrepreneurship: Definition and Concept of entrepreneurship - Entrepreneur Characteristics – Classification of Entrepreneurs –Role of Entrepreneurship in Economic Development –Start-ups	**06 Hours**
Module-II Idea Generation and Project Formulation: Ideas in Entrepreneurships – Sources of New Ideas – Techniques for Generating Ideas – Preparation of Project Report –Contents;	**06 Hours**
Module-III Guidelines for Report preparation – Project Appraisal Techniques –Economic Analysis-Financial Analysis-Market Analysis.	**05 Hours**
Module-IV Central level Institutions: NABARD; SIDBI,– Tax Incentives and Concessions.	**05 Hours**
Module-V State Level Institutions –DICs – SFC - Government Policy for MSMEs - Tax Incentives and Concessions.	**06 Hours**

Reference Books:

1. Arya Kumar, Entrepreneurship, Pearson, Delhi
2. Poornima MCH, Entrepreneurship Development –Small Business Enterprises, Pearson, Delhi
3. Sangeetha Sharma, Entrepreneurship Development, PHI Learning
4. KanishkaBedi, Management and Entrepreneurship, Oxford University Press, Delhi
5. Anil Kumar, S., ET.al., Entrepreneurship Development, New Age International Publishers, New Delhi
6. Khanka, SS, Entrepreneurship Development, S. Chand, New Delhi
7. Peter F. Drucker, Innovation and Entrepreneurship
8. A.Sahay, M. S. Chhikara, New Vistas of Entrepreneurship: Challenges &Opportunities
9. Dr B E V L Naidu, Entrepreneurship. Seven Hills Publishers

Course outcomes: **On completion of the course, the student will have the ability to:**	
CO #	**Course Outcome (CO)**
CO1	Understand the concept of Entrepreneurship, its applications and scope.
CO2	Know various types of financial institutions that help the business at Central, State and Local Level
CO3	Understand Central and State Government policies, Aware of various tax incentives, concessions
CO4	Applies the knowledge for generating a broad idea for a starting an enterprise/start up
CO5	Understand the content for preparing a Project Report for a start up and differentiate between financial, technical analysis and business feasibility.

Suggested Co-Curricular Activities (As far as possible)

1. Group Discussion
2. Debate
3. Seminar
4. Visit to an SSI and preparing of an outline Report
5. Invited Lecture by a Bank Employee on the Bank Support to a Start Up.
6. Chart showing tax concessions to SSI, MSME both direct and indirect.

CIE FOR THE COURSES WITH 01 CREDIT

a) **CIE THEORY COMPONENT**

The CIE theory component constitutes of CIE IA Test with maximum 25 marks and minimum passing 10 marks

CIE CCAs with maximum 25 marks and minimum passing 10 marks

- There shall be three Continuous Internal Evaluations (CIE) for 1. Credit course
- The CIE Question paper shall be set for a maximum of 30 marks with questions having a maximum of three bits.
- The question needs to be framed covering the entire syllabus (33%) completed before the consecutive CIEs.
- The cumulative marks of the three CIE is to be divided by 3.6 to reduce the final CIE marks to a maximum of 25 marks and the minimum passing mark for this is 10.
- Another 25 marks are dedicated to other assessment tools with suitable weightage for each, that include quizzes, assignments, mini-projects, presentations, case studies, surveys, group discussions, slip tests etc, and minimum passing marks for this is 10. (Any two assessment tools may be used. The assessment tools must be discussed and got approved by the concerned HoD before the commencement of the course)

b) SEMESTER END EXAMINATIONS:

- The SEE theory exam to be conducted for 50 marks with minimum passing marks 18.
- The SEE question paper with Multiple Choice Question (MCQs) type is set for 50 questions each of the 01 marks.

Introduction to Augmented Reality			
Subject Code:	**21MEAE583**	Credits: 01	CIE: 50
Number of Lecture Hours/Week	2 (Tutorial)		SEE: 50
Total Number of Lecture Hours	28		SEE Hours: 03

Course objectives:

1. Describe how AR systems work and list the applications of AR.
2. Understand and analyse the hardware requirement of AR.
3. Use computer vision concepts for AR and describe AR techniques
4. Analyse and understand the working of various state of the art AR devices
5. Acquire knowledge of mixed reality

Module	Total Hours
Module I **Introduction to Augmented Reality (A.R**): Defining augmented reality, history of augmented reality, The Relationship between Augmented Reality and Other Technologies-Media, Technologies, Other Ideas Related to the Spectrum between Real and Virtual Worlds, applications of augmented reality. **Augmented Reality Concepts-** Concepts Related to Augmented Reality, Ingredients of an Augmented Reality Experience.	**8 Hours**
Module II **Augmented Reality Hardware:** **Augmented Reality Hardware – Displays** – Audio Displays, Haptic Displays, Visual Displays, Other sensory displays, Visual Perception , Requirements and Characteristics, Spatial Display Model. **Processors –** Role of Processors, Processor System Architecture, Processor Specifications. **Tracking & Sensors -** Tracking, Calibration, and Registration, Characteristics of Tracking Technology, Stationary Tracking Systems, Mobile Sensors, Optical Tracking, Sensor Fusion.	**8 Hours**
Module III **Computer Vision for Augmented Reality & A.R. Software:** Computer Vision for Augmented Reality - Marker Tracking, Multiple-Camera Infrared Tracking, Natural Feature Tracking by Detection, Simultaneous Localization and Mapping, Outdoor Tracking. **Augmented Reality Software -** Introduction, Major Software Components for Augmented Reality Systems, Software used to Create Content for the Augmented Reality Application.	**8 Hours**
Module IV **AR Techniques- Marker based & Markerless tracking:** Marker-based approach-Introduction to marker-based tracking, types of markers, marker camera pose and identification, visual tracking, mathematical representation of matrix multiplication **Marker types-** Template markers, 2D barcode markers, imperceptible markers. Marker-less approachLocalization based augmentation, real world examples **Tracking methods-** Visual tracking, feature based tracking, hybrid tracking, and initialization and recovery.	**5 Hours**

Module V	5 Hours
AR Devices & Components : AR Components – Scene Generator, Tracking system, monitoring system, display, Game scene. **AR Devices –** Optical See- through HMD, Virtual retinal systems, Monitor bases systems, Projection displays, and Video see-through systems	

Text Book:

1. Allan Fowler-AR Game Development‖, 1st Edition, A press Publications, 2018, ISBN 978-1484236178
2. Augmented Reality: Principles & Practice by Schmalstieg / Hollerer, Pearson Education India; First edition (12 October 2016),ISBN-10:

Reference Books:

1. Designing for Mixed Reality, Kharis O'Connell Published by O'Reilly Media, Inc., 2016, ISBN: 9781491962381
2. Sanni Siltanen- Theory and applications of marker-based augmented reality. Julkaisija – Utgivare Publisher. 2012. ISBN 978-951-38-7449-0

Web links and Video Lectures (e-Resources):
https://www.vttresearch.com/sites/default/files/pdf/science/2012/S3.pdf
https://docs.microsoft.com/en-us/windows/mixed-reality/
https://docs.microsoft.com/en-us/archive/msdn-magazine/2016/november/hololensintroduction-to-the-hololens

MOOC Courses: https://www.coursera.org/learn/ar•
https://www.udemy.com/share/101XPi/•

Course outcome (Course Skill Set) At the end of the course the student will be able to:

CO1	Describe how AR systems work and list the applications of AR.
CO2	Understand and analyse the hardware requirement of AR.
CO3	Use computer vision concepts for AR and describe AR techniques
CO4	Analyse and understand the working of various state of the art AR devices
CO5	Acquire knowledge of mixed reality

CIE FOR THE COURSES WITH 01 CREDIT

a) **CIE THEORY COMPONENT**

The CIE theory component constitutes of CIE IA Test with maximum 25 marks and minimum passing 10 marks

CIE CCAs with maximum 25 marks and minimum passing 10 marks

- There shall be three Continuous Internal Evaluations (CIE) for 1. Credit course
- The CIE Question paper shall be set for a maximum of 30 marks with questions having a maximum of three bits.

- The question needs to be framed covering the entire syllabus (33%) completed before the consecutive CIEs.
- The cumulative marks of the three CIE is to be divided by 3.6 to reduce the final CIE marks to a maximum of 25 marks and the minimum passing mark for this is 10.
- Another 25 marks are dedicated to other assessment tools with suitable weightage for each, that include quizzes, assignments, mini-projects, presentations, case studies, surveys, group discussions, slip tests etc, and minimum passing marks for this is 10. (Any two assessment tools may be used. The assessment tools must be discussed and got approved by the concerned HoD before the commencement of the course)

b) SEMESTER END EXAMINATIONS:

- The SEE theory exam to be conducted for 50 marks with minimum passing marks 18.
- The SEE question paper with Multiple Choice Question (MCQs) type is set for 50 questions each of the 01 marks.

INFORMATION AND COMMUNICATION TECHNOLOGY (ICT)			
Subject Code	**21MEAE584**	**Credits: 01**	**CIE: 50**
Number of Lecture Hours/Week	**2 (Tutorial)**		**SEE: 50**
Total Number of Lecture Hours	**28**		**SEE Hours: 03**

PREREQUISITE: NIL

COURSE OBJECTIVES:
This course aims at acquainting the students with basic ICT tools which help them in their day to day and life as well as in office and research.

Modules	Teaching Hours
Modules-I Fundamentals of Internet: What is Internet?, Internet applications, Internet Addressing – Entering a Web Site Address, URL–Components of URL, Searching the Internet,	05 hrs
Modules-II Browser–Types of Browsers, Introduction to Social Networking: Twitter, Tumblr, LinkedIn, Facebook, flickr, Skype, yahoo, YouTube, WhatsApp.	05 hrs
Module-III Definition of E-mail -Advantages and Disadvantages –User Ids, Passwords, Email Addresses, Domain Names, Mailers, Message Components, Message Composition, Mail Management. G-Suite: Google drive, Google documents, Google spread sheets, Google Slides and Google forms.	06 hrs
Module-IV Overview of Internet security, E-mail threats and secure E-mail, Viruses and antivirus software, Firewalls, Cryptography, Digital signatures, Copyright issues.	06 hrs
Module-IV What are GOI digital initiatives in higher education? (SWAYAM, Swayam Prabha, National Academic Depository, National Digital Library of India, E-Sodh-Sindhu, Virtual labs, e-acharya, e-Yantra and NPTEL).	06 hrs

Reference Books:

1. In-line/On-line: Fundamentals of the Internet and the World Wide Web, 2/e –By RaymondGreen law and Ellen Hepp, Publishers: TMH
2. Internet technology and Web design, ISRD group, TMH.
3. Information Technology – The breaking wave, Dennis P.Curtin, Kim Foley, Kunai Sen andCathleen Morin, TMH.

Course outcomes: On completion of the course, the student will have the ability to:		
Course Code	**CO #**	**Course Outcome (CO)**
	CO1	Understand the literature of social networks and their properties.
	CO2	Explain which network is suitable for whom.
	CO3	Develop skills to use various social networking sites like twitter, flickr, etc.
	CO4	Learn few GOI digital initiatives in higher education.
	CO5	Apply skills to use online forums, docs, spreadsheets, etc for communication, collaboration andresearch.
	CO6	Get acquainted with internet threats and security mechanisms

RECOMMENDED CO-CURRICULAR ACTIVITIES: Co-curricular activities shall not promote copying from textbook or from others work and shall encourage self/ independent and group learning.

1. Assignments (in writing and doing forms on the aspects of syllabus content and outside the syllabus content. Shall be individual and challenging)
2. Student seminars (on topics of the syllabus and related aspects (individual activity))
3. Quiz and Group Discussion
4. Slip Test
5. Try to solve MCQ's available online.
6. Suggested student hands on activities:

a. Create your accounts for the above social networking sites and explore them, establish a video conference using Skype.
b. Create an Email account for yourself- Send an email with two attachments to another friend. Group the email addresses use address folder.
c. Register for one online course through any of the online learning platforms like NPTEL, SWAYAM, Alison, Codecademy, Coursera. Create a registration form for your college campus placement through Google forms.

CIE FOR THE COURSES WITH 01 CREDIT

a) **CIE THEORY COMPONENT**

The CIE theory component constitutes of CIE IA Test with maximum 25 marks and minimum passing 10 marks

CIE CCAs with maximum 25 marks and minimum passing 10 marks

- There shall be three Continuous Internal Evaluations (CIE) for 1. Credit course
- The CIE Question paper shall be set for a maximum of 30 marks with questions having a maximum of three bits.
- The question needs to be framed covering the entire syllabus (33%) completed before the consecutive CIEs.
- The cumulative marks of the three CIE is to be divided by 3.6 to reduce the final CIE marks to a maximum of 25 marks and the minimum passing mark for this is 10.
- Another 25 marks are dedicated to other assessment tools with suitable weightage for each, that include quizzes, assignments, mini-projects, presentations, case studies, surveys, group

discussions, slip tests etc, and minimum passing marks for this is 10. (Any two assessment tools may be used. The assessment tools must be discussed and got approved by the concerned HoD before the commencement of the course)

b) SEMESTER END EXAMINATIONS:

- The SEE theory exam to be conducted for 50 marks with minimum passing marks 18.
- The SEE question paper with Multiple Choice Question (MCQs) type is set for 50 questions each of the 01 marks.

B.E VI Sem

OPERATIONS RESEARCH			
Subject Code	**21ME61**	**Credits: 03**	**CIE: 50**
Number of Lecture Hours/Week	**3 (Theory)**		**SEE: 50**
Total Number of Lecture Hours	**42**		**SEE Hours: 03**

PREREQUISITE: Fundamentals of Mathematics, Statistics and Probability.

COURSE OBJECTIVES:

1. Fundamentals of OR, formulation of linear programming problems. Graphical solution, Simplex method, Big M method.
2. Various types of transportation and assignment problems
3. Network analysis (PERT/CPM).
4. Sequencing machine problems and Queuing model.

Modules	Teaching Hours
Module-I **INTRODUCTION TO OR:** Definition, scope of Operations Research (O.R) approach and limitations of OR Models, Characteristics and phases of OR Mathematical formulation of L.P. Problems. Graphical solution methods. **LINEAR PROGRAMMING PROBLEMS:** Basic Solutions, Feasible Solutions, Optimal Solutions, Degenerate Solutions, Simplex methods. Big-M method in LPP.	**9 Hours**
Module-II **TRANSPORTATION PROBLEM:** Formulation of Transportation Model, Basic Feasible Solution by NWC Rule, Lowest cost entry and Vogel approximation methods. Unbalanced problem, Optimality Method, (MODI method for optimality check) degeneracy in transportation. **ASSIGNMENT PROBLEM:** Formulation, Hungarian Method, Unbalanced Problem, Assignment for Maximization, Traveling Salesman Problem.	**9 Hours**
Module-III **CPM- TECHNIQUES:** Network Construction, determination of critical path and Total Elapsed time, Concept of slack and Float. **PERT TECHNIQUES:** Network Construction, Estimation of Project duration and Variance, analysis about the completion of projects. Crashing of simple network.	**9 Hours**
Module-IV **SEQUENCING:** Terminology & Notations, Principle assumptions, Solution of sequencing problem: Processing of n - jobs through 2 machines, n jobs through 3 machines, Processing 2 jobs through m machines, processing n jobs through m machines. **GAME THEORY:** Formulation of Games, Characteristics of games, Two-Person Zero Sum game, Maximin/ Minimax principle, Saddle point, games without saddle point, Solution for (2 x 2) game, dominance property, Graphical solution for (2 x n) and (n x 2) game.	**9 Hours**

Module V	
REPLACEMENT PROBLEM: Basic Concept of Replacement of items that deteriorate with time: costs involved Replacement procedure with and without consideration of Time value of money. Replacement of items that Fail suddenly: Group Replacement. **QUEUEING THEORY:** Queuing systems and their characteristics, Pure-birth and Pure-death models (only equations), empirical queuing models –M/M/1 problems.	**8 Hours**

Question paper pattern:

Total of Ten Questions with Two questions from each Module to be set covering the entire syllabus.
Five full questions are to be answered selecting at least One full question from each Module.
Each question should not have more than 3 sub divisions.

Text books:

1. Taha S A –"Opeartions Research and Introduction", McMillian
2. S.D.Sharma –"Opeartions Research", Kedarnath, Ramnath and Co.

Reference Books:

1. Hiller and Liberman-" Introduction to Operations Research", McGraw Hill V Edn
2. Philips, Ravindran and Soeberg- "Principles of Operations research", PHI

Course outcomes:
On completion of the course, the student will have the ability to:

CO #	Course Outcome (CO)
CO1	Recognize the importance and value of Operations Research and formulate research models to solve real life problems for allocating limited resources by linear programming.
CO2	Apply transportation and assignment models to real life situations.
CO3	Apply project management techniques like CPM and PERT to plan and execute project successfully.
CO4	Apply sequencing and Games theory concepts in industry applications.
CO5	Apply the mathematical tool for decision making regarding replacement of items in real life and apply queuing theory for performance evaluation of engineering and management systems.

Note: CIE FOR 03 CREDIT PROFESSIONAL CORE COURSE

The CIE theory component constitutes of

- CIE IA Test with maximum 25 marks and minimum passing 10 marks
- CIE CCAs with maximum 25 marks and minimum passing 10 marks
- There shall be three Continuous Internal Evaluations (CIE) for the courses with 03 credits.
- The CIE Question paper shall be set for a maximum of 30 marks with questions having a maximum of three bits.

The question needs to be framed covering the entire syllabus (33%) completed before the consecutive CIEs.

The cumulative marks of the three CIE is to be divided by 3.6 to reduce the final CIE marks to a maximum of 25 marks and the minimum passing mark for this is 10.

Another 25 marks are dedicated to other assessment tools with suitable weightage for each, that include quizzes, assignments, mini-projects, presentations, case studies, surveys, group discussions, slip tests, etc, and the minimum passing mark for this is 10 (If the assessment is mini-project based

then only one assessment method may be adopted or otherwise, any two assessment tools may be used.

SEMESTER END EXAMINATION (SEE):

Theory SEE will be conducted by scheduled timetable, with question papers for the subject (duration 03 hours).

The question paper shall be set for 100 marks.

The duration of SEE is 03 hours. The question paper will have 10 questions. Two questions per module. Each question is set for 20 marks.
Students have to answer 5 full questions, selecting one full question from each module.
The student has to answer for 100 marks and marks scored out of 100 shall be proportionally reduced to 50 marks.

There will be 2 questions from each module. Each of the two questions under a module

HEAT AND MASS TRANSFER			
Subject Code	**21ME62**	**Credits: 04**	**CIE: 50**
Number of Lecture Hours/Week	**3 (Theory) +2(Practical)**		**SEE: 50**
Total Number of Lecture Hours	**42**		**SEE Hours: 03**

PREREQUISITE: : 1. Knowledge of heat interactions learnt in thermal engineering subjects prior to study of heat and mass transfer.
2. Knowledge of basic differentiation and integration.

COURSE OBJECTIVES:

i)To familiarize the student regarding heat and mass transfer phenomenon occurring in various systems

ii)Apply the principles to real processes, so as to achieve maximum performance

Modules	Teaching Hours
Module-I **STEADY STATE HEAT CONDUCTION:** Introduction regarding modes of heat transfer. General heat conduction equation in Cartesian co-ordinates. Boundary and initial conditions. Temperature distribution and heat flow through Slab, hollow cylinder and hollow sphere with uniform thermal conductivity. Electrical Analogy for solving conduction heat transfer problems. Heat flow through composite slabs, composite cylinders and composite spheres. Concept of overall heat transfer coefficient Critical. Thickness of insulation for cylinder and sphere.	11 hrs
Module-II **UNSTEADY STATE HEAT CONDUCTION:** Lumped system analysis. Time constant and response of temperature measuring instruments. Transient heat conduction in solids with finite conduction and convective resistances. Transient conduction with given temperature distribution. Heisler charts for solving unsteady state conduction problems. **EXTENDED SURFACES:** Temperature distribution and heat flow through a rectangular fin-general expression, when the end of the fin is insulated and Fin is infinite.	11 hrs
Module-III **NATURAL CONVECTION:** Dimensionless empirical relation for heat transfer coefficient using Buckingham pi theorem. Physical significance of dimensionless numbers used in natural convection. Empirical Correlations for free convection-plates and cylinders. **FORCED CONVECTION:** Physical mechanism. Physical significance of dimensionless numbers used in forced convection.	10 hrs

Module-IV **THERMAL RADIATION:** Basic theories of radiation heat transfer. Reflectivity, Absorptivity, Transmissivity. Concept of black body, Planck's law of radiation, Wien's displacement law, total emissive power, Stefan-Boltzman law, Concept of Grey body, emissivity, Kirchoff's law of radiation. **HEAT EXCHANGERS:** Introduction, Types of heat exchangers, heat exchanger analysis, Logarithmic temperaturedifferenceforparallelandcounterflow,Temperature distribution and heat flow in condenser and evaporator, Overall heattransfercoefficient,heatexchangereffectivenessbyNTUmethodforparalleland counterflow.	10 hrs
Module V **BOILING AND CONDENSATION :** Boiling heat transfer-General aspects, boiling regimes, factors affecting nucleate boiling, Condensation: Drop wise and film wise condensation, Laminar film condensation on a vertical plate. **MASS TRANSFER:** Introduction, modes of mass transfer, concentrations, velocitiesand fluxes, Fick's law, General mass diffusion equation in stationary media, steadystate diffusion through- a plain membrane and a cylindrical shell.	10 hrs

Question paper pattern:

1.Total of Ten Questions with Two questions from each Module to be set covering the entire syllabus.
2.Five full questions are to be answered selecting at least One full question from each Module.
3.Each question should not have more than 4 sub divisions.

Text books:

1 Heat and Mass Transfer by Domkundwar, Dhanpat Rai Publications, 2012
2 Heat and Mass Transfer by R K Rajput, Laxmi Publications, 2012

Reference Books:

1 Heat Transfer by J P Holman, Tata Mc Graw Hill Co-Ltd, New Delhi
2 Heat Transfer by M N Ozisik, Tata Mc Graw Hill Co-Ltd, New Delhi
3 Heat Transfer by Yunus A Cengel, Tata Mc Graw Hill Co-Ltd, New Delhi
4 Heat and Mass Transfer by B N Veeranna, Sudha Publications, Bangalore.

Course outcomes:
On completion of the course, the student will have the ability to:

Course Code	CO #	Course Outcome (CO)
	CO1	Understanding the principles and application of conduction mode of heat transfer to steady state.
	CO2	Understanding the principles & application of conduction mode of heat transfer to unsteady state.
	CO3	Ability to deal with the principles and application of forced and free convection mode of heat transfer.
	CO4	Ability to deal with the principles and application of thermal radiation mode of heat transfer, temperature Distribution and heat flow in heat exchangers.
	CO5	Understanding the principles & application of boiling, condensation heat transfer and Mass Transfer.

HEAT TRANFER LAB

PREREQUISITE: 1. Knowledge of heat interactions learnt in thermal engineering subjects prior to study of heat and mass transfer.
2. Knowledge of basic differentiation and integration.

COURSE OBJECTIVES:

1. To introduce to the student, the various modes of heat energy transfer with a pre-requisite knowledge of fluid mechanics and thermodynamics.

2. To understand the heat exchange in different types of heat exchangers.

Modules	Teaching Hours
Determination of thermal conductivity of insulating materials using lagged pipe apparatus. Determination of thermal conductivity of materials using Composite wall apparatus.	6 hrs
Determination of heat transfer coefficient using Natural convection apparatus. Determination of heat transfer coefficient using Forced convection apparatus	7 hrs
Determination of emissivity of surfaces using Emissivity apparatus.	2 hrs
Determination of effectiveness of parallel flow heat exchanger. Determination of effectiveness of counter flow heat exchanger	7 hrs
Determination of Stefan Boltzman constant. Determination of condensation heat transfer coefficient.	6 hrs

Course outcomes:
On completion of the course, the student will have the ability to:

Course Code	CO #	Course Outcome (CO)
	CO1	Determine experimentally the laws of conduction heat transfer using lagged pipe apparatus, composite wall apparatus
	CO2	Determine experimentally the laws of convection heat transfer using natural convection apparatus.
	CO3	Determine experimentally the laws of radiation heat transfer using emissivity apparatus, stefan-boltzman apparatus.
	CO4	Determine experimentally the effectiveness of parallel and counter flow heat exchanger using heat exchanger set up.
	CO5	Determine experimentally the laws of convection heat transfer using forced convection apparatus

I) CIE AND SEE FOR THE INTEGRATED PROFESSIONAL CORE COURSE (IPCC) WITH 4 CREDITS (L-T-P: 3-0-2)

a) CIE THEORY COMPONENT

The CIE theory component constitutes of

- CIE - Internal Assessment Test with maximum 15 marks with minimum passing 6 marks
- CIE - Continuous and Comprehensive Assessment with maximum 10 marks with minimum passing 4 marks

There shall be three Continuous Internal Evaluations (CIE)

- The CIE Question paper shall be set for a maximum of 30 marks with questions having a maximum of three bits.
- The question needs to be framed covering the entire syllabus (33%) completed before the consecutive CIEs.
- The cumulative marks of the three CIE is to be divided by 6 to reduce the final CIE marks to a maximum of 15 marks and the minimum passing mark for this is 6.
- Another 10 marks are dedicated to other assessment tools with suitable weightage for each, that include quizzes, assignments, mini-projects, presentations, case studies, surveys, group discussions, slip tests, etc, and the minimum passing mark for this is 4. (If the assessment is mini-project based then only one assessment method may be adopted or otherwise, any two assessment tools may be used.
- The laboratory component of the IPCC shall be for CIE only no SEE.

b) CIE PRACTICAL COMPONENT

The CIE practical component constitutes of

- CIE Practical with maximum 15 marks and minimum passing 6 marks
- CIE Practical Test with maximum 10 marks and minimum passing 4 marks

- The maximum marks dedicated for conducting the experiments and preparation of laboratory records is 15 with minimum passing marks 6.
- The final CIE practical test for 50 marks to be conducted after completion of all the experiments and the scored marks is reduced to the maximum of 10 with minimum passing marks 4.

The maximum marks for both CIE theory and Practical is 50 and minimum passing marks is 20

DESIGN OF MACHINE ELEMENTS-II			
Subject Code	**21ME63**	**Credits: 03**	**CIE: 50**
Number of Lecture Hours/Week	**2 (Theory) +2(Tutorial)**		**SEE: 50**
Total Number of Lecture Hours	**42**		**SEE Hours: 03**

PREREQUISITE:

1)Mathematical methods such as Differentiation, Integration, Linear differential equations, Geometry of plane surfaces,

2) Mechanics of materials: Stress, strain, Elastic constants, Types of loads and stresses, center of gravity & moment of inertia,

3) Design of machine Elements-I: Factor of safety, Properties of engineering materials, Design for Static and fatigue loading.

COURSE OBJECTIVES:

1. To introduce to Winkler Bach equation and apply it for the computation of tensile and compressive stresses for the given static load conditions on curved beams & and principles for the design of mechanical systems involving springs.
2. To be able to understand the terminologies used for gears and design the spur gears and helical gears from static load, dynamic load and wear considerations.
3. To be able to design suitable sliding contact bearings and rolling contact bearings for the given operating conditions.
4. To design bevel gears, worm & worm gears considering the specified operating conditions.
5. To be able to design suitable I.C.Engine parts such as Piston, Connecting rod, valve mechanism for the given service conditions.

Modules	**Teaching Hours**
Module-I **Design of Curved Beams:** Winkler Bach equation, Stresses in curved beams of standard and simple cross sections used in crane hooks, Punching presses, Clamps (such as isosceles triangle, square, rectangle, circle and rhombus, Solid and hollow). **Springs:** Types of springs, terminology – Stresses in Helical coil springs of circular sections, Energy stored in springs. Concentric springs, springs under fluctuating loads.	8 hrs
Module-II **Design of Spur Gears**: Terminology, Lewis beam equation, Tooth form factor, design of Spur gears from strength consideration in Bending, Wear and Dynamic loading, Gear materials and suggesting suitable hardness. **Design of Helical Gears:** Tooth relationship, tooth proportions, Formative teeth number, Design of simple Helical Gears and double Helical Gears from strength, dynamic load and wear considerations. Suggesting suitable hardness.	8 hrs

Module-III **Lubrication and Sliding Contact Bearing:** Types of lubrication, Viscosity, Hydrodynamic theory of Lubrication, Types of Bearings, Dimensionless numbers, Design of Bearings using Design Charts, Boundary lubrication, Hydrostatic bearing, Hydrodynamic bearings, Thrust bearings. **Anti-Friction Bearings:** Types of ball bearings, Roller bearings, Needle bearings, life of Bearings in hours and millions of revolutions, Reliability considerations, Selection of ball bearings, roller bearings for the specified operating conditions and given axial load, thrust load and fluctuating loads. .	10 hrs
Module-IV **Worm Gears**: Types of Worm gearing, Analysis of forces, Power rating, Efficiency, Worm gear standards and proportions, Artificial cooling, Design of worm and worm wheel for given transmission ratio and other operating conditions. **Bevel Gears:** Straight bevel gears, Types of bevel gears, Back cone, Formative teeth number, Design of bevel gears for Bending, wear and Dynamic loading.	8 hrs
Module V **Design of I.C.Engine Piston and Connecting Rod:** Different parts of an I.C.Engine, Function of each part, material used, Design of piston for the given operating condition, Selection of suitable I – section for main body of connecting rod, Design of connecting rod for the given operating conditions. **Design of Valve Gear Mechanism: V**alve mechanism for the given operating conditions.	8 hrs

Text books:

1. Design of Machine Elements By V B Bhandari, McGraw Hill

2. Machine Design By R S Khurmi, S. Chand Publications

Reference Books:

1. Mechanical Engineering Design By Shigley & Mische, McGraw Hill

2. Machine Design By Black & Adams, McGraw Hill

Course outcomes:

On completion of the course, the student will have the ability to:

Course Code	CO #	Course Outcome (CO)
	CO1	Design curved beams standard cross sections spring for given operating conditions.
	CO2	Design Spur gear and helical gear considering strength, wear and dynamic loading.
	CO3	Design worm gear and bevel gear as per the given requirements and conditions.
	CO4	Design Sliding contact bearings and Rolling contact bearings as per the given conditions.
	CO5	Design I.C.Engine parts such as piston. connecting rod, and valve gear mechanism

Note: CIE FOR 03 CREDIT PROFESSIONAL CORE COURSE

The CIE theory component constitutes of

- CIE IA Test with maximum 25 marks and minimum passing 10 marks
- CIE CCAs with maximum 25 marks and minimum passing 10 marks
- There shall be three Continuous Internal Evaluations (CIE) for the courses with 03 credits.
- The CIE Question paper shall be set for a maximum of 30 marks with questions having a maximum of three bits.

The question needs to be framed covering the entire syllabus (33%) completed before the consecutive CIEs.

The cumulative marks of the three CIE is to be divided by 3.6 to reduce the final CIE marks to a maximum of 25 marks and the minimum passing mark for this is 10.

Another 25 marks are dedicated to other assessment tools with suitable weightage for each, that include quizzes, assignments, mini-projects, presentations, case studies, surveys, group discussions, slip tests, etc, and the minimum passing mark for this is 10 (If the assessment is mini-project based then only one assessment method may be adopted or otherwise, any two assessment tools may be used.

SEMESTER END EXAMINATION (SEE):

Theory SEE will be conducted by scheduled timetable, with question papers for the subject (duration 03 hours).

The question paper shall be set for 100 marks.

- The duration of SEE is 03 hours. The question paper will have 10 questions. Two questions per module. Each question is set for 20 marks.
- Students have to answer 5 full questions, selecting one full question from each module.
- The student has to answer for 100 marks and marks scored out of 100 shall be proportionally reduced to 50 marks.
- There will be 2 questions from each module. Each of the two questions under a module

Professional Elective-I (21ME64X)

REFRIGERATION AND AIR CONDITIONING			
Subject Code	**21ME641**	**Credits: 03**	**CIE: 50**
Number of Lecture Hours/Week	**3 (Theory)**		**SEE: 50**
Total Number of Lecture Hours	**42**		**SEE Hours: 03**

PREREQUISITE: Refrigeration engineering courses are geared toward students who want to design and build refrigeration as well as heating, ventilation and air conditioning (HVAC) systems.

COURSE OBJECTIVES:

- Study the basic definition, Nomenclature for refrigerating systems.
- Understand the working principles and applications of different types of refrigeration systems.
- Study the working of air conditioning systems and their applications.
- Identify the performance parameters and their relations of an air conditioning system.

Modules	Teaching Hours
Module-I **Introduction:** Air Refrigeration Cycles, Units Refrigeration, Coefficient of Performance of a Refrigerator, Difference Between a Heat Engine, Refrigerator and Heat Pump Open Air Refrigeration Cycle, Closed or Dense Air Refrigeration Cycle, Air Refrigerator Working on Reversed Carnot Cycle, Temperature Limitations for Reversed Carnot Cycle, Air Refrigerator Working on a Bell Coleman Cycle, Applications of Refrigeration and Air Conditioning, Problems. **Air Refrigeration Systems:** Introduction, Merits and Demerits of Air Refrigeration System, Methods of Air Refrigeration Systems, Simple Air-Cooling System, Simple Air Evaporative Cooling system, problems.	8 hrs
Module-II **Simple Vapor Compression Refrigeration Systems:** Introduction, Advantages and Disadvantages of Vapor Compression Refrigeration System Over Air Refrigeration System, Mechanism of a Simple Vapor Compression Refrigeration System, Pressure - Enthalpy Chart, Types of Vapour Compression Cycles, Theoretical Vapour Compression Cycle with Dry, wet and superheated Vapour after Compression, Theoretical Vapour Compression Cycle with Superheated Vapour before Compression, Theoretical Vapour Compression Cycle with Under-cooling or Subcooling of Refrigerant, Simple Saturation Cycle with Flash Chamber, Simple Saturation Cycle with Accumulator or Pre-cooler, Simple Saturation Cycle with Sub-cooling of Liquid Refrigerant by Vapour Refrigerant. **Compound Vapour Compression Refrigeration Systems:** Introduction, Advantages of Compound for Multi-stage) Vapour Compression with Intercooler , Types of Compound Vapour Compression with Intercooler, Two Stage Compression with Liquid Intercooler, Water Intercooler and Liquid Sub-cooler, Two Stage Compression with Water Intercooler, Liquid Sub cooler and Liquid Flash Chamber, Two Stage Compression with Water Intercooler, Liquid Sub-cooler and Flash Intercooler, Three Stage Compression with Water Intercoolers, Three Stage Compression with Flash Chambers, Three Stage Compression with Flash Intercoolers, Three Stage Compression with Multiple Expansion Valves and Flash Intercoolers.	9 hrs

Module-III **Vapour Absorption Refrigeration Systems:** Introduction, Simple Vapour Absorption System, Practical Vapour Absorption System, Properties of Ideal Refrigerant - Absorbent Combination, Comparisons of Refrigerant-Liquid Absorbent Combination with Refrigerant - Solid Absorbent - Combination , Advantages of Vapour Absorption Refrigeration System over Vapour Compression Refrigeration System, Coefficient of Performance of an Ideal Vapour Absorption Refrigeration System, Domestic Electrolux (Ammonia Hydrogen) Refrigerator, Lithium Bromide Absorption Refrigeration System, problems. **Refrigerants:** Introduction, Desirable Properties of an Ideal Refrigerant, Classification of Refrigerants, Halo-carbon Refrigerants, Azeotrope Refrigerants, Inorganic Refrigerants, Hydrocarbon Refrigerants, Designation System for Refrigerants, Subtitles for Chloro-Fluro-Carbon CF Refrigerants, Comparison of Refrigerants, Thermodynamic Properties of Refrigerants, Chemical Properties of Refrigerants Secondary Refrigerant – Brines.	8 hrs
Module-IV **Psychrometry:** Introduction**,** Psychrometric Terms**,** Dalton's Law of Partial Pressures**,** Psychrometric Relations**,** Enthalpy (Total heat) of Moist air**,** Thermodynamic Wet Bulb Temperature or Adiabatic Saturation Temperature**,** Psychrometric Chart**,** Psychrometric Processes**,** Sensible Cooling**,** By-pass Factor of Heating and Cooling Coil**,** Efficiency of Heating and Cooling Coils**,** Humidification and Dehumidification**,** Methods of Obtaining Humidification and Dehumidification**,** Cooling and Dehumidification**,** Cooling with Adiabatic Humidification**,** Cooling and Humidification by Water Injection (Evaporative Cooling)**,** Heating and Humidification**,** Heating and Humidification by Steam Injection**,** Heating and Dehumidification -Adiabatic Chemical Dehumidification**,** Adiabatic Mixing of Two Air Streams, problems. **Air Conditioning Systems:** Introduction, Air Conditioning System, Equipment's Used in an Air Conditioning System, Classification of air Conditioning Systems, Comfort Air Conditioning System, Industrial Air Conditioning System, Winter Air Conditioning System, Summer Air Conditioning System, Central Air Conditioning System, Room Sensible Heat Factor, Grand Sensible Heat Factor, Effective Room Sensible Heat Factor, problems.	9 hrs
Module V **Ducts:** Introduction, Classification of Ducts, Duct Material, Duct Construction, Duct Shape, Pressure in Ducts, Continuity Equation for Ducts, Bernoulli's Equation for Ducts, Pressure Losses in Ducts, Pressure loss due to Friction in Ducts, Friction Factor for Ducts, Equivalent Diameter of a Circular Duct for a Rectangular Duct, Friction Chart for Circular Ducts, Dynamic losses in Ducts, Duct Design, Methods for Determination of Duct Size. **Fans:** Introduction, Types of Fans, Total Pressure Developed by a Fan, Fan Air Power, Fan Efficiencies, Fan Performance Curves, Velocity Triangles for Moving Blades of a Centrifugal Fan, Work Done and Theoretical Total Head Developed by a Centrifugal Fan for Radial Entry of Air, Specific Speed of a Centrifugal Fan, Fan Similarly Laws, Fan and System Characteristic, Fans in Series, Fansin Parallel.	8 hrs

Text books:

1). Refrigeration and Air-conditioning – by C . P Arorar, Tata McGraw Hill Publication.ll Edition, 2001.

2) Manohar Prasad Refrigration and Air-conditioning Willey Eastern limited,New Delhi1983

Reference Books:

1. Stocker Refrigration and Air-conditioning Tata McGraw Hill Publishing company limited new Delhi 1981.
2. Roy J Dossat "Principals of Refrigration S I version Willey Eastern limited New Delhi 1985.
3. Refrigration and Air-conditioning by Jordon & Priester PHI Publications 1995.
4. Thermodynamics Data Hand book by Nijaguna & Samaga 2002.

Course outcomes:
On completion of the course, the student will have the ability to:

CO #	Course Outcome (CO)
CO1	Illustrate the principles, nomenclature and applications of refrigeration systems.
CO2	Explain vapour compression refrigeration system and identify methods for performance improvement
CO3	Study the working principles of air, vapour absorption, thermoelectric and thermoacoustic refrigeration systems.
CO4	Estimate the performance of air-conditioning systems using the principles of psychrometry.
CO5	Compute and Interpret cooling and heating loads in an air-conditioning system.

Note: CIE FOR 03 CREDIT PROFESSIONAL CORE COURSE

The CIE theory component constitutes of

- CIE IA Test with maximum 25 marks and minimum passing 10 marks
- CIE CCAs with maximum 25 marks and minimum passing 10 marks
- There shall be three Continuous Internal Evaluations (CIE) for the courses with 03 credits.
- The CIE Question paper shall be set for a maximum of 30 marks with questions having a maximum of three bits.
- The question needs to be framed covering the entire syllabus (33%) completed before the consecutive CIEs.
- The cumulative marks of the three CIE is to be divided by 3.6 to reduce the final CIE marks to a maximum of 25 marks and the minimum passing mark for this is 10.

  Another 25 marks are dedicated to other assessment tools with suitable weightage for each, that include quizzes, assignments, mini-projects, presentations, case studies, surveys, group discussions, slip tests, etc, and the minimum passing mark for this is 10 (If the assessment is mini-project based then only one assessment method may be adopted or otherwise, any two assessment tools may be used.

SEMESTER END EXAMINATION (SEE):

Theory SEE will be conducted by scheduled timetable, with question papers for the subject (duration 03 hours).

The question paper shall be set for 100 marks.

- The duration of SEE is 03 hours. The question paper will have 10 questions. Two questions per module. Each question is set for 20 marks.
- Students have to answer 5 full questions, selecting one full question from each module.
- The student has to answer for 100 marks and marks scored out of 100 shall be proportionally reduced to 50 marks.
- There will be 2 questions from each module. Each of the two questions under a module

HYDRAULICS AND PNEUMATICS		
Subject Code	**21ME642** | **Credits: 03**	**CIE: 50**
Number of Lecture Hours/Week	**3 (Theory)**	**SEE: 50**
Total Number of Lecture Hours	**42**	**SEE Hours: 03**

PREREQUISITE: 1. Fundamental understanding of Physical laws like Pascal's law and others.
2. Knowledge of power transmission methods like electrical and mechanical and others.
3. Logic thinking capabilities, Basics of Binary Algebra.

COURSE OBJECTIVES:

1. The course elaborates principles of Hydraulic and Pneumatic devices.
2. Gives an overview of control systems associated with Hydraulic and Pneumatic applications.
3. Imparts knowhow of design and analysis of Circuits for different typical Engineering applications.
4. The course gives an insight into the maintenance and troubleshooting aspects of FP Engineering.
5. Imports knowledge are logic control devise.

Modules	Teaching Hours
Module-I **INTRODUCTION:** Introduction hydraulics and pneumatics with basic block diagram with advantages, limitations and application, Pascal's law with power transmission and Power multiplication, continuity equation, Bernoulli's theorem, Frictional losses in fluid flow(Laminar & turbulent flow and Reynolds number). **HYDRAULIC PUMPS**: Introduction to pump, classification of pumps, construction and working principle of 1.Gearpumps:- (Internal pump, External pump, Lobe pump) 2. Vane pumps: - (Unbalanced vane pump and Balance vane pump) 3. Piston pumps: - (Axial piston pump, Bent Axis type axial pump).	8 hrs
Module-II **HYDRAULIC ACTUATORS&MOTORS:** Linear actuators:- Hydraulic cylinders(Single acting cylinder, Double acting cylinder and special cylinders, Double rod cylinder, Tandem cylinder and Telescopic cylinder) Lever Systems for loading Hydraulic cylinders. Rotary actuators:- Hydraulic motor (gear motor, vane motor and piston motor) **HYDRAULIC CONTROL ELEMENTS:** Classification of Hydraulic valves. I. Direction control valves :- Valve Representations and symbols, valve actuation mechanisms and symbols, Operation of check valves (Poppet type check valve, poppet valve with push button actuated, pilot operated check valve) and Sliding spool valve (3/2, 4/2, 4/3 spool valves) and Solenoid controlled valve. II. Pressure control valves: - Simple pressure Relief valve, compound pressure Relief valve and Pressure reducing valve. III. Flow control valves: - Simple needle Valve, Needle valve with integral check valve and Pressure compensated flow control valve.	9 hrs

Module-III **DESIGN AND ANALYSIS OF HYDRAULIC CIRCUITS:** Design and analysis of typical hydraulic circuits. Regenerative circuits, Synchronization circuits, and Sequencing circuits, Meter-in, Meter-out and Bleed-off circuits; Fail Safe and Counter balancing circuits. **HYDRAULIC SYSTEM ACCESSORIES AND MAINTENANCE:** Construction of Reservoirs, Construction of Hydraulic Accumulators:- (Dead weight, Spring loaded and gas loaded Accumulators) Maintenance of hydraulic system:- Causes of hydraulic system problem, safety considerations and environmental issues.	8 hrs
Module-IV **COMPRESSED AIR GENERATION AND PNEUMATIC ACTUATORS:** Air compressors, classification(piston type, Screw type, Diaphragm type compressors) stages of air preparation and secondary air treatment Using FRL UNIT Pneumatic actuators:- Linear cylinders(single acting cylinder, Double acting cylinder, Rodless cylinder, Diaphragm cylinder),Seals in air cylinders, Rotary actuators:- Air motor (vane air motor ,Axial piston air motor) **PNEUMATIC CONTROL COMPONENTS:** Introduction and classification of control elements, Valves, types, constructional details, Symbolic representation, 3/2, 5/2spool valves, Non return check valve, flow control valve, throttle valve.	9 hrs
Module-V **DESIGN AND ANALYSIS OF PNEUMATIC CIRCUITS:** Direct and Indirect control of single and double acting cylinders, quick exhaust valve, Speed control of cylinders using FCV(supply air and exhaust air throttling) **LOGIC CONTROLS:** Logic devices, use of logic gates, OR, AND, NANO, NOR in pneumatic applications, practical examples involving the use of logic gates.	8 hrs

Question paper pattern:

Total of Ten Questions with Two questions from each Module to be set covering the entire syllabus.
Five full questions are to be answered selecting at least one full question from each Module.
Each question should not have more than 4 sub divisions.

Text books:

1) Anthony Esposito," Fluid Power with applications", Pearson Education.
2) Andrew parr, Hydraulics and Pneumatics, A technician and engineers guide, Butterwortb, Heinemann

Reference Books:

1) SR Mujumdar, oil hydraulic systems, principles and maintenance, McGraw Hill Education
2) Joji P, Pneumatic Controls, Wiley India Pvt. Ltd.
3) Pippenger J J , and R.M. Koff, Fluid Power Control systems, New York: McGraw Hill.

Course outcomes:

On completion of the course, the student will have the ability to:

CO#	Course Outcome (CO)
CO1	Describe the hydraulic and pneumatic system with Basic governing law for fluid Power and Different type of pump.
CO2	Illustrate the hydraulic actuators and control elements of hydraulic system
CO3	Design the hydraulic circuits and Accessories in hydraulic system

CO4	Comprehend and Illustrate the Pneumatic compressors ,Pneumatic actuators and control elements
CO5	Design the basic of Pneumatic circuits and Discuss the Pneumatic circuits using logic controls

Note: CIE FOR 03 CREDIT PROFESSIONAL CORE COURSE

The CIE theory component constitutes of

- CIE IA Test with maximum 25 marks and minimum passing 10 marks
- CIE CCAs with maximum 25 marks and minimum passing 10 marks
- There shall be three Continuous Internal Evaluations (CIE) for the courses with 03 credits.
- The CIE Question paper shall be set for a maximum of 30 marks with questions having a maximum of three bits.

The question needs to be framed covering the entire syllabus (33%) completed before the consecutive CIEs.

The cumulative marks of the three CIE is to be divided by 3.6 to reduce the final CIE marks to a maximum of 25 marks and the minimum passing mark for this is 10.

Another 25 marks are dedicated to other assessment tools with suitable weightage for each, that include quizzes, assignments, mini-projects, presentations, case studies, surveys, group discussions, slip tests, etc, and the minimum passing mark for this is 10 (If the assessment is mini-project based then only one assessment method may be adopted or otherwise, any two assessment tools may be used.

SEMESTER END EXAMINATION (SEE):

Theory SEE will be conducted by scheduled timetable, with question papers for the subject (duration 03 hours).

The question paper shall be set for 100 marks.

- The duration of SEE is 03 hours. The question paper will have 10 questions. Two questions per module. Each question is set for 20 marks.
- Students have to answer 5 full questions, selecting one full question from each module.
- The student has to answer for 100 marks and marks scored out of 100 shall be proportionally reduced to 50 marks.
- There will be 2 questions from each module. Each of the two questions under a module

MACHINE TOOL DESIGN			
Subject Code	**21ME643**	**Credits: 03**	**CIE: 50**
Number of Lecture Hours/Week	**3 (Theory)**		**SEE: 50**
Total Number of Lecture Hours	**42**		**SEE Hours: 03**

PREREQUISITE: Basics knowledge of strength of materials and manufacturing processes.

COURSE OBJECTIVES:

1. To apply the knowledge of strength of materials and manufacturing processes in the machine tool design
2. To understand the intricacy of machine tool layout.
3. To have the knowledge of different drives in machine tools.
4. To study the design of structure of machine tool design.
5. To analyze the dynamic stability of machine tools

Modules	Teaching Hours
Module-I **PRINCIPLES OF MACHINE TOOL DESIGN:** General requirement of machine tool design- design process machine toll layout. **GENERAL REQUIREMENTS OF MACHINE TOOLS:** Center lathe, Milling machine.	7 hrs
Module-II **MACHINE TOOL DRIVES AND MECHANISMS:** Working and auxiliary motion. Drives- electric drives. Hydraulic transmission, Mechanical transmission. Kinematic structure. Regulation of speed and feeds. Stepped regulation, standardization of speed and feed, stepless regulation of speeds and feeds. Cutting force analysis and power requirement in turning, Milling, Drilling, shaping and broaching operation (with simple problems).	8 hrs
Module-III **DESIGN OF MACHINE TOOL STRUCTURES:** Functions- Requirements- Design criteria Material used- static and dynamic stiffness- Profile and basic design procedure for machine tool structure, Design of beds, columns, housing, bases, tables, cross- rails, arms, saddle, carriages.	6 hrs
Module-IV **DESIGN OF GUIDE WAYS AND POWER SCREWS:** Functions and types of guide ways- Design and lubrication of slide ways- Aerostatic slide ways- Antifriction slide ways, combination guide ways- Protecting devices, design of power screws. **DESIGN OF SPINDLE AND SPINDLE BEARINGS:** Functions- Requirements and materials for spindle compliance and machining accuracy, design of spindles- Antifriction bearings, hydrodynamics and hydrostatic bearing, Air lubricated bearing .	11 hrs

Module V	
DYNAMICS OF MACHINE TOOLS: Concept of dynamic cutting process, Physical causes of chatter and vibrations, Types of chatters, Stability charts, Chatter vibrations- Lathe- Drilling machine- Grinding machine, Milling machine, Different methods for avoiding machine tool chapter and vibrations. **CONTROL SYSTEM IN MACHINE TOOL:** Functions, Requirements, and classifications. Control system for speed and feeds centralize control pre-selective control, control system foe forming and auxiliary motions- Mechanical control- Ergonomics considerations and compatibility- Automatic control. System- Electrical Hydraulic- Pneumatic systems.	10 hrs

Question paper pattern:

1. Total of Ten Questions with Two questions from each Module to be set covering the entire syllabus.
2. Five full questions are to be answered selecting at least One full question from each Module.
3. Each question should not have more than 4 sub divisions.

Text books:

1. N K Metha, Machine Tool Design, TATA McGraw-Hill 2001.
2. N Acharkan, Machine Tool Design, Volume II and III MIR Publications, 2000.

Reference Books:

1. S K Basu and D K Pal, Design of Machine Tools, 2000
2. Sen and Bhattacharya, Principles of Machine Tools, Oxford I.B M Publications. 2000.

Course outcomes:

On completion of the course, the student will have the ability to:

Course Code	CO #	Course Outcome (CO)
	CO1	Understand the general requirements of a machine tool.
	CO2	Able to apply the design principles in designing machine tool parts.
	CO3	Learn the different drives present in a machine tool
	CO4	Estimate the dynamic stability of machine tools subjected to chatter
	CO5	Understands different control systems in machine tools.

Note: CIE FOR 03 CREDIT PROFESSIONAL CORE COURSE

The CIE theory component constitutes of

- CIE IA Test with maximum 25 marks and minimum passing 10 marks
- CIE CCAs with maximum 25 marks and minimum passing 10 marks
- There shall be three Continuous Internal Evaluations (CIE) for the courses with 03 credits.
- The CIE Question paper shall be set for a maximum of 30 marks with questions having a maximum of three bits.

The question needs to be framed covering the entire syllabus (33%) completed before the consecutive CIEs.

The cumulative marks of the three CIE is to be divided by 3.6 to reduce the final CIE marks to a maximum of 25 marks and the minimum passing mark for this is 10.

Another 25 marks are dedicated to other assessment tools with suitable weightage for each, that include quizzes, assignments, mini-projects, presentations, case studies, surveys, group discussions, slip tests, etc, and the minimum passing mark for this is 10 (If the assessment is mini-project based then only one assessment method may be adopted or otherwise, any two assessment tools may be used.

SEMESTER END EXAMINATION (SEE):

Theory SEE will be conducted by scheduled timetable, with question papers for the subject (duration 03 hours).

The question paper shall be set for 100 marks.

- The duration of SEE is 03 hours. The question paper will have 10 questions. Two questions per module. Each question is set for 20 marks.
- Students have to answer 5 full questions, selecting one full question from each module.
- The student has to answer for 100 marks and marks scored out of 100 shall be proportionally reduced to 50 marks.
- There will be 2 questions from each module. Each of the two questions under a module

ROBOTICS AND ROBOT APPLICATIONS			
Subject Code	**21ME644**	**Credits: 03**	**CIE: 50**
Number of Lecture Hours/Week	**3 (Theory)**		**SEE: 50**
Total Number of Lecture Hours	**42**		**SEE Hours: 03**

PREREQUISITE:

1.The development and use of robot is essential to the mechanical engineers with basic skills of kinematics and dynamics of the components along with transmission of power.
2. Fundamental knowledge of mathematics, matrix algebra.

COURSE OBJECTIVES:

1. To familiarize students with brief history of robot and basic concepts of industrial Robot.
2. To expose the students to kinematics of robots and programming of robot.
3. To make the students familiar with various applications in robots in industry

Modules	Teaching Hours
Module-I **Introduction:** Automation and robotics brief history of robotics, social and economic aspects of robots, advantages and disadvantages of using robots in industries. Overview of robots-present and future applications. Industrial and biomedical applications of robots. **Classification and Structure of Robotic System:** Classifications geometrical configurations, wrist and its motions, end effectors and its types, links and joints. **Robot Drive Systems:** Hydraulic, electric and pneumatic drive systems, resolution, accuracy and repeatability, advantages and disadvantages of drive.	8 hrs
Module-II **Control Systems and Components:** Basic control system concepts and models, transformation and block diagram of spring mass system, controllers-ON and OFF, proportional integral, proportional and integral, transient and response to second order system. Robot actuation and Feedback component. Robot end effectors and grippers. Tooling, Robot safety collaborative.	8 hrs
Module-III **Robot Arm Kinematics:** Kinematics – Introduction, direct and inverse kinematics, rotation matrix,composite rotation matrix, rotation matrix about an arbitrary axis, Euler angles representation, homogeneous transformations, links, joint and their parameters, D-H representation. **Introduction Robot Arm Dynamics & Applications of Robots**: Lagrange – Euler formulations – Joint velocities, Kinetic energy, potential energy and motion equations of a robot manipulator. Industrial & Biomedical applications of Robots.	10 hrs
Module-IV **Trajectory Planning:** Introduction, general considerations on trajectory planning, joint interpolated trajectories, 4-3-4 trajectory example. Planning of Cartesian path trajectories. **Robot Programming:** Introduction, manual teaching, lead through teaching, programming languages – AML and –VAL – [simple examples], Programming with graphics, storing and operating, Task programs.	8 hrs

Module V	
Sensors: Internal state sensors, tactile sensors, - proximity sensing, range sensing, and force – torque sensors, Elements of computer vision. Sensing and digitizing function in machine vision – image devices – lighting techniques – analog to digital signal conversion – sampling – quantization – encoding – image storage. Image processing and analysis, Feature Extraction and object recognition.	8 hrs

Question paper pattern:

1.Total of Ten Questions with Two questions from each Module to be set covering the entire syllabus.

2.Five full questions are to be answered selecting at least One full question from each Module.

3.Each question should not have more than 3 sub divisions.

Text books:

1. Industrial Robotics – Groover. Mc Graw Hill 2003
2. Robotics – K.S.Fu, R.C, Gonzales and Lee, Mc Graw Hill International 1987.

Reference Books:

1.Robot manipulators, Mathematics, Programming and Control- Richard Paul.2000
2.Robotics – Yorem Coren, Mc Graw Hill Intl, Book Co., New Delhi2001
3.Fundamentals of Robotics – Robert J Schilling 2003
4.Robotic Engg, - Richard D. Klafter, PHI.2003
5.Robotics and Control by R.K. Mittal and J Nagarath, Tata Mc Graw Hil, 1995

Course outcomes:
On completion of the course, the student will have the ability to:

Course Code	CO #	Course Outcome (CO)
	CO1	Will have the knowledge of fundamentals of robotics, graphics, and configurations of serial manipulators, workspace, frames, 3D transformations
	CO2	Describe the concepts of Euler's angles, Differential velocities, D-H Representation, Forward and Inverse kinematics, fuzzy logic and robot vision.
	CO3	Application of Calculus & Linear algebra, for kinematics, dynamics & trajector planning respectively.
	CO4	Analysis of serial manipulators using Lagragian and Newton-Euler formulation, 3D transformations and D-H parameters.
	CO5	Development of generic algorithms to perform various robot tasks and obtain the robot program.

Note: CIE FOR 03 CREDIT PROFESSIONAL CORE COURSE

The CIE theory component constitutes of

- CIE IA Test with maximum 25 marks and minimum passing 10 marks
- CIE CCAs with maximum 25 marks and minimum passing 10 marks
- There shall be three Continuous Internal Evaluations (CIE) for the courses with 03 credits.
- The CIE Question paper shall be set for a maximum of 30 marks with questions having a maximum of three bits.

The question needs to be framed covering the entire syllabus (33%) completed before the consecutive CIEs.

The cumulative marks of the three CIE is to be divided by 3.6 to reduce the final CIE marks to a maximum of 25 marks and the minimum passing mark for this is 10.

Another 25 marks are dedicated to other assessment tools with suitable weightage for each, that include quizzes, assignments, mini-projects, presentations, case studies, surveys, group discussions, slip tests, etc, and the minimum passing mark for this is 10 (If the assessment is mini-project based then only one assessment method may be adopted or otherwise, any two assessment tools may be used.

SEMESTER END EXAMINATION (SEE):

Theory SEE will be conducted by scheduled timetable, with question papers for the subject (duration 03 hours).

The question paper shall be set for 100 marks.

- The duration of SEE is 03 hours. The question paper will have 10 questions. Two questions per module. Each question is set for 20 marks.
- Students have to answer 5 full questions, selecting one full question from each module.
- The student has to answer for 100 marks and marks scored out of 100 shall be proportionally reduced to 50 marks.
- There will be 2 questions from each module. Each of the two questions under a module

OPERATIONS MANAGEMENT			
Subject Code	**21ME645**	**Credits: 03**	**CIE: 50**
Number of Lecture Hours/Week	**3 (Theory)**		**SEE: 50**
Total Number of Lecture Hours	**42**		**SEE Hours: 03**

PREREQUISITE:

COURSE OBJECTIVES:

1.Apply the various methods of forecasting
2. Define capacity and utilization and their relationship to financial performance measures.
3. Define the key performance measures to consider the need for the schedule.
4. Design of Conversion process systems in manufacturing and service organizations.
5. Illustrate the role of operations, and their interaction with the other activities of a firm: finance, marketing, organization, corporate governance, etc.

Modules	Teaching Hours
Module-I **Using operations to create value**: Role of operations in an organization, a process view, a supply chain view, operations strategy, competitive priorities and capabilities, addressing the trends and challenges in operations management, decision making models	8 hrs
Module-II **Process strategy and analysis:** process structure in services, process structure in manufacturing, process strategy decisions, strategic fit, strategies for change, documenting and evaluating the process, redesigning and managing process improvements	8 hrs
Module-III **Planning capacity:** Planning long term capacity, planning timing and sizing strategies, a systematic approach to long term capacity decisions, tools for capacity planning, waiting line models. **Managing process constraints:** the theory of constraints, managing bottlenecks in service and manufacturing processes, applying the theory of constraints to product mix decisions, managing constraints in line processes. .	9 hrs
Module-IV **Forecasting Demand:** managing demand, key decisions on making forecasts, forecast error, judgment methods, causal methods: linear regression, time series, forecasting as a process. **Managing Inventories:** inventory tradeoffs, types of inventory, inventory reduction tactics, ABC Analysis, economic order quantity, continuous review system, modeling review system, special inventory models.	9 hrs

Module V	
Planning and Scheduling Operations: levels in operations planning and scheduling, S&OP supply options, S&OP strategies, scheduling. **Efficient resource planning:** Material requirements planning, master production scheduling, MRP explosion, enterprise resource planning, resource planning for service providers.	8 hrs

Question paper pattern:

1.Total of Ten Questions with Two questions from each Module to be set covering the entire syllabus.

2.Five full questions are to be answered selecting at least One full question from each Module.

3.Each question should not have more than 4 sub divisions.

Text books:

1.Operations Management – Processes and Supply Chain,Lee J Karjewski and Larry P Ritzman, Manoj Malhotra, 11th Edition, 2010, Pearson Education Asia, ISBN: 0133872467, 9780133872460 2. Internal Combustion Engines, M. L. Mathur and R. P. Sharma, DhanpatRai Publications, 2014.

2. Production and Operations Management, R. Paneerselvam, 2nd Edition, 2006, PHI, ISBN:81-203-2767-5

Reference Books:

1. Operations Management – Theory and Practice, B. Mahadevan, 2nd Edition, 2010, PHI, ISBN: 978 8131730706
2. Productions & Operations Management, Adam & Ebert, 5th Edition, 2002, Prentice Hall, ISBN – 013718008-X.

Course outcomes:

On completion of the course, the student will have the ability to:

Course Code	CO #	Course Outcome (CO)
	CO1	Explain the concept and scope of operations management in a business context
	CO2	Recognize the role of Operations management among various business functions and its role in the organizations' strategic planning and gaining competitive advantage.
	CO3	Analyze the appropriateness and applicability of a range of operations management systems/models in decision making.
	CO4	Assess a range of strategies for improving the efficiency and effectiveness of organizational operations.
	CO5	Evaluate a selection of frameworks used in the design and delivery of operations

Note: CIE FOR 03 CREDIT PROFESSIONAL CORE COURSE

The CIE theory component constitutes of

- CIE IA Test with maximum 25 marks and minimum passing 10 marks
- CIE CCAs with maximum 25 marks and minimum passing 10 marks
- There shall be three Continuous Internal Evaluations (CIE) for the courses with 03 credits.
- The CIE Question paper shall be set for a maximum of 30 marks with questions having a maximum of three bits.

The question needs to be framed covering the entire syllabus (33%) completed before the consecutive CIEs.

The cumulative marks of the three CIE is to be divided by 3.6 to reduce the final CIE marks to a maximum of 25 marks and the minimum passing mark for this is 10.

Another 25 marks are dedicated to other assessment tools with suitable weightage for each, that include quizzes, assignments, mini-projects, presentations, case studies, surveys, group discussions, slip tests, etc, and the minimum passing mark for this is 10 (If the assessment is mini-project based then only one assessment method may be adopted or otherwise, any two assessment tools may be used.

SEMESTER END EXAMINATION (SEE):

Theory SEE will be conducted by scheduled timetable, with question papers for the subject (duration 03 hours).

The question paper shall be set for 100 marks.

- The duration of SEE is 03 hours. The question paper will have 10 questions. Two questions per module. Each question is set for 20 marks.
- Students have to answer 5 full questions, selecting one full question from each module.
- The student has to answer for 100 marks and marks scored out of 100 shall be proportionally reduced to 50 marks.

There will be 2 questions from each module. Each of the two questions under a module

Open Elective – I(21ME65OEX)

INDUSTRIAL MANAGEMENT AND ERGONOMICS			
Subject Code	**21ME65OE1**	**Credits: 03**	**CIE: 50**
Number of Lecture Hours/Week	**3 (Theory)**		**SEE: 50**
Total Number of Lecture Hours	**42**		**SEE Hours: 03**

PREREQUISITE: Basic knowledge of Industrial engineering and management.

COURSE OBJECTIVES:

1. The main objective of this course is to provide students with skills in systematic analysis of work methods, work measurement and work design to improve productivity.
2. Understand the concepts of productivity and use of scientific methods.
3. Learn to create graphical tools like process charts and diagrams to analyze and improve an operation.
4. Understand the use of motion analysis and the principles of motion Economy to design/re-design a workplace.
5. Learn to compute standard times for operations from direct time studies, fundamentals of standard data systems, predetermined time standards and work sampling.

Modules	Teaching Hours
Module-I **PRODUCTIVITY AND WORK STUDY:** Definition of Productivity, individual enterprises, task of management. Productivity of materials, land, building, machine and power. Measurement of productivity, factors affecting productivity, measures to improve productivity. **WORK STUDY:** Definition, advantages and procedure of Work study, objective and scope of work-study. Human factors in work study. Work study and management,	9 hrs
Module-II **METHOD STUDY** : Definition, objective, procedure scope of method study, types of recording techniques and their applications, therbligs, principles of motion economy, classification of movements, micro-motion study. Development, definition and installation of the improved method.	8 hrs
Module-III **WORK MEASUREMENTS:** Definition, objectives and benefit of work measurement, work measurement techniques. **STOP WATCH TIME STUDY**- definition, time study equipment, selection of job, steps in time study, breaking the job into elements, recording information, Rating, scales of rating, factors affecting rate of working, standard performance, allowances and standard time determination.	8 hrs
Module-IV **ERGONOMICS:** Definition and importance, areas of study under ergonomics, system approach to ergonomics model system, work capabilities of industrial worker, Measuring Work by Physiological means. Work Posture, Anthropometry- Need, Important Body Dimensions, Data Collection, Statistical Analysis, Percentile.	8 hrs

Module V **DESIGN OF MAN-MACHINE SYSTEMS:** man-machine system. Components of man-machine and their functions, Fatigue in industrial workers, Fatigue Measurement and Evaluation, Quantitative and qualitative representation, alphanumeric displays, controls and their design criteria, control types, relation between controls and displays. **DESIGN OF WORKPLACE:** Human performance under, heat, and cold, illumination, vibration, noise pollution.	9 hrs

Question paper pattern:

1. Total of Ten Questions with Two questions from each Module to be set covering the entire syllabus.
2. Five full questions are to be answered selecting at least One full question from each Module.
3. Each question should not have more than 4 sub divisions.

Text books:

1. O.P Khanna, Dhanpat Rai & sons, Industrial Engineering and Management.
2. Bhanga and Sharma, Industrial Engineering and Ergonomics.

Reference Books:

1. ILO, Introduction to Work study
2. M. S. Sanders and Ernest J. McCormick, McGraw Hill Inc., Human Factors Engineering and Design
3. Barnes Ralph, Motion and Time Study – Design and Measurement of Work Wiley 4. Suresh Dalela - Work Study and ergonomics,

Course outcomes:

On completion of the course, the student will have the ability to:

CO #	Course Outcome (CO)
CO1	The student should be able to understand the importance of productivity
CO2	The student should be able to use various charts and diagrams to analyze and develop improved methods of working
CO3	The student should be able to determine the time standards.
CO4	The student should understand the importance of human factors and ergonomics in productivity improvement.
CO5	Knowledge to plan and design the ergonomically according to the requirement of the comfort to the engineer to work satisfactorily.

Note: CIE FOR 03 CREDIT PROFESSIONAL CORE COURSE

The CIE theory component constitutes of

- CIE IA Test with maximum 25 marks and minimum passing 10 marks
- CIE CCAs with maximum 25 marks and minimum passing 10 marks
- There shall be three Continuous Internal Evaluations (CIE) for the courses with 03 credits.
- The CIE Question paper shall be set for a maximum of 30 marks with questions having a maximum of three bits.

The question needs to be framed covering the entire syllabus (33%) completed before the consecutive CIEs.

The cumulative marks of the three CIE is to be divided by 3.6 to reduce the final CIE marks to a maximum of 25 marks and the minimum passing mark for this is 10.

Another 25 marks are dedicated to other assessment tools with suitable weightage for each, that include quizzes, assignments, mini-projects, presentations, case studies, surveys, group discussions, slip tests, etc, and the minimum passing mark for this is 10 (If the assessment is mini-project based then only one assessment method may be adopted or otherwise, any two assessment tools may be used.

SEMESTER END EXAMINATION (SEE):

Theory SEE will be conducted by scheduled timetable, with question papers for the subject (duration 03 hours).

The question paper shall be set for 100 marks.

- The duration of SEE is 03 hours. The question paper will have 10 questions. Two questions per module. Each question is set for 20 marks.
- Students have to answer 5 full questions, selecting one full question from each module.
- The student has to answer for 100 marks and marks scored out of 100 shall be proportionally reduced to 50 marks.
- There will be 2 questions from each module. Each of the two questions under a module

MICRO ELECTRO-MECHANICAL SYSTEMS (MEMS)				
Subject Code	**21ME65OE2**	Credits	03	CIE: 50
Number of Lecture Hours/Week	3 (Theory)			SEE: 50
Total Number of Lecture Hours	42			SEE Hours: 03
Prerequisite:				
Course Objectives: · Understand overview of microsystems, their fabrication and application areas. · Working principles of several MEMS devices. · Develop mathematical and analytical models of MEMS devices. · Know methods to fabricate MEMS devices. · Various application areas where MEMS devices can be used.				
Modules				**Teaching Hours**
MODULE-I **Overview of MEMS and Microsystems:** MEMS and Microsystem, Typical MEMS and Microsystems Products, Evolution of Microfabrication, Microsystems and Microelectronics, Multidisciplinary Nature of Microsystems, Miniaturization. Applications and Markets.				08 Hours
MODULE-II **Working Principles of Microsystems:** Introduction, Microsensors, Microactuation, MEMS with Microactuators, Microaccelerometers, Microfluidics. **Engineering Science for Microsystems Design and Fabrication:** Introduction, Molecular Theory of Matter and Intermolecular Forces, Plasma Physics, Electrochemistry.				10 Hours
MODULE-III **Engineering Mechanics for Microsystems Design:** Introduction, Static Bending of Thin Plates, Mechanical Vibration, Thermomechanics, Fracture Mechanics, Thin Film Mechanics, Overview on Finite Element Stress Analysis.				08 Hours
MODULE-IV **Scaling Laws in Miniaturization:** Introduction, Scaling in Geometry, Scaling in Rigid-Body Dynamics, Scaling in Electrostatic Forces, Scaling in Fluid Mechanics, Scaling in Heat Transfer.				08 Hours
MODULE-V **Overview of Micromanufacturing:** Introduction, Bulk Micromanufacturing, Surface Micromachining, The LIGA Process, Summary on Micromanufacturing.				08 Hours
Question paper pattern: 1. Total of Ten Questions with two from each MODULE to be set covering the entire syllabus. 2. Five full questions are to be answered choosing at least one from each MODULE. 3. Each question should not have more than 4 sub divisions.				
Text books: 1. Tai-Ran Hsu, MEMS and Micro systems: Design, Manufacture and Nanoscale Engineering, 2nd Ed, Wiley.				

Reference Books:

1. Hans H. Gatzen, Volker Saile, JurgLeuthold, Micro and Nano Fabrication: Tools and Processes, Springer, 2015.
2. Dilip Kumar Bhattacharya, Brajesh Kumar Kaushik, Microelectromechanical Systems (MEMS), Cenage Learning.

E books and online course materials:

Course outcomes:
On completion of the course, the student will have the ability to:

CO #	Course Outcome (CO)
CO1	Appreciate the technologies related to Micro Electro Mechanical Systems.
CO2	Understand design and fabrication processes involved with MEMS devices.
CO3	Analyse the MEMS devices and develop suitable mathematical models
CO4	Know various application areas for MEMS device
CO5	Learn various application areas for micromanufacturing

Note: CIE FOR 03 CREDIT PROFESSIONAL CORE COURSE

The CIE theory component constitutes of

- CIE IA Test with maximum 25 marks and minimum passing 10 marks
- CIE CCAs with maximum 25 marks and minimum passing 10 marks
- There shall be three Continuous Internal Evaluations (CIE) for the courses with 03 credits.
- The CIE Question paper shall be set for a maximum of 30 marks with questions having a maximum of three bits.

The question needs to be framed covering the entire syllabus (33%) completed before the consecutive CIEs.

The cumulative marks of the three CIE is to be divided by 3.6 to reduce the final CIE marks to a maximum of 25 marks and the minimum passing mark for this is 10.

Another 25 marks are dedicated to other assessment tools with suitable weightage for each, that include quizzes, assignments, mini-projects, presentations, case studies, surveys, group discussions, slip tests, etc, and the minimum passing mark for this is 10 (If the assessment is mini-project based then only one assessment method may be adopted or otherwise, any two assessment tools may be used.

SEMESTER END EXAMINATION (SEE):

Theory SEE will be conducted by scheduled timetable, with question papers for the subject (duration 03 hours).

The question paper shall be set for 100 marks.

- The duration of SEE is 03 hours. The question paper will have 10 questions. Two

questions per module. Each question is set for 20 marks.

- Students have to answer 5 full questions, selecting one full question from each module.
- The student has to answer for 100 marks and marks scored out of 100 shall be proportionally reduced to 50 marks.
- There will be 2 questions from each module. Each of the two questions under a module

COMPUTER AIDED DRAFTING (CAD) LAB.			
Subject Code	**21MEL66**	**Credits: 01**	**CIE: 50**
Number of Lecture Hours/Week	**2 (Practical)**		**SEE: 50**
Total Number of Lecture Hours	**28**		**SEE Hours: 03**

PREREQUISITE: 1) Geometry of plane surfaces 2) Engineering Graphics: First angle projection, Orthographic projections, Isometric views/projections. 3) Computer/Laptop : Basic operations, Printer.

COURSE OBJECTIVES:

1. To introduce to AUTOCAD software to create required drawings using various commands
2. To be able to create orthographic projections of a given object/casting in first angle projection using AUTOCAD software.
3. To be able to create sectional views of intricate object/casting in first angle projection using AUTOCAD software.
4. To be able to create isometric views of object/casting referring to its orthographic projections in first angle projection using AUTOCAD software.
5. To be able to dimension the figure, place the texts and take print out of the same.

Modules-I	**Teaching Hours**
INTRODUCTION: Introduction to AUTOCAD software, Basic commands, Drawing commands and modifying commands. Creating simple figures using straight lines and circle commands. Block insertion, Concept of layers.	3 hrs
ORTHOGRAPHIC PROJECTIONS: Creating orthographic projections of given objects/castings following first angle projections, Linear dimensioning, Editing Dimension styles as per requirements, Placing and editing texts, Executing PRINT command properly.	5 hrs
SECTIONAL VIEWS: Concept of Section plane and its representation, Creating sectional views of intricate objects/castings. Dimensioning and Executing PRINT command properly. .	6 hrs
Module-II **ISOMETRIC VIEWS:** Creating Isometric views of objects/castings from their orthographic projections. Aligned dimensioning and placing the texts and arrows in proper direction, Executing PRINT command properly.	8 hrs
3D MODELLING: Introduction to basic 3D operations, Creating simple 3D objects such as prisms and cylinders, Creating 3D models of combined solids (Maximum of 3 solids, not necessarily co axial)	6 hrs

Question paper pattern:
1.Two questions, one on drawing orthographic projections and the other on drawing pictorial view of given casting or machine component.(40 Marks)CIE I 20 CIE II 20
2.Viva – voce carries 10 Marks.

Course outcomes:
On completion of the course, the student will have the ability to:

Course Code	CO #	Course Outcome (CO)
	CO1	Demonstrate the ability to construct an accurate 2-D drawing, to create and edit textual data utilizing appropriate drawing software ie AUTOCAD.
	CO2	Perform editing and entity manipulation operations on selected geometry and to generate cross hatched sectional views and pattern fills using AUTOCAD.
	CO3	Demonstrate the ability to fully dimension 2 -D geometry using linear, angular and associative and edit dimensioning style as required.
	CO4	Demonstrate the ability to visualize and create 3-D objects on paper and dimension properly.
	CO5	Demonstrate the plot command to generate paper drawings and understand the various basic commands to create simple 3D models using AUTOCAD