GOVERNMENT COLLEGE OF ENGINEERING, KARAD

(*An Autonomous Institute of Government of Maharashtra*)

DEPARTMENT OF MECHANICAL ENGINEERING

Curricula for

THIRD YEAR B.TECH MECHANICAL ENGINEERING

As per NEP-2020

w.e.f AY 2025-26

Chairman BoS
Mechanical Engineering Dept.
Govt. College of Engg., Karad

THIRD YEAR

B.TECH MECHANICAL ENGINEERING

COURSE SYLLABI

FOR

SEMESTER V

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Mechanical Engineering Dept.
Govt. College of Engg., Karad

Government College of Engineering, Karad				
Third Year (Sem – V) B. Tech. Mechanical Engineering				
ME3501: Manufacturing Engineering				
Teaching Scheme			**Examination Scheme**	
Lectures	03 Hrs/week		MSE	20
Tutorials	--		ISE	20
Total Credits	03		ESE	60
			Duration of ESE	03Hrs

Prerequisite : Machine Tools & Processes

Course Outcomes (CO): Students will be able to

CO1	Understand & identify the metal cutting action with different cutting tool
CO2	Design jigs and fixtures for simple components
CO3	Analyze the tooling system used for advanced manufacturing like CNCand understand different parameters of costing
CO4	Designa press tool die for different components.

	Course Contents	CO	Hours
Unit 1	**Cost Estimation** Definition, Purpose of Cost Estimation and Cost Accounting, Difference between Cost Accounting and Cost Estimation, Types of costs, direct cost, indirect cost, fixed cost, variable cost, elements of cost, material, labor, expenses, factory, selling and distribution, overheads,cost structure, machine hour rate, breakeven point analysis	**CO3**	**(06)**
Unit 2	**Mechanics of Metal Cutting** Introduction to metal cutting, wedge action, concept of speed, feed and depth of cut, orthogonal and oblique cutting. Parts, angles and types of single point cutting tools, tool geometry of single point cutting tool, Mechanics of metal cutting-Chip formation, Types of chips, cutting ratio, Theory of shear angle, shear plane shear stress & strain, velocity relationships, Types of tool dynamometers, estimation of cutting forces, Merchants circle of forces, cutting tool materials and their properties, Machinability of metals- factors affecting, improvement and Machinability index	**CO1**	**(08)**
Unit 3	**Theory of Metal Cutting** Tool life - Types of wear, relationship with cutting parameters, Taylor's equation and improvement measures. Surface finish- Factors affecting, effect of cutting parameters, improvements. Tool life and surface finish, types and selection criteria of cutting fluids. Tool geometry& types - of multipoint cutting tools- drills, milling cutters,reamers	**CO1**	**(06)**
Unit 4	**Design of Jigs and Fixtures (Special Tooling)** Definition, Applications, Basic elements, Principles and Types of Locating, Clamping and Indexing elements, Auxiliary elements like Tenon, Setting block etc. Type of Drilling jigs and Milling fixtures- design consideration of jigs and fixtures with respect to different operations, introduction of Computer Aided Fixture Designing (CAFD)	**CO2**	**(09)**
Unit 5	**Introduction Advanced Manufacturing** CNC Technology & CNC Tooling: Introduction, Construction and working of CNC and machining center, Automatic Tool Changer (ATC) and Automatic Tool Setter, Automatic pallet changer (APC). G code, M codes	**CO3**	**(05)**
Unit 6	**Press Tools** Press working terminology, Elements of Dies and Punch set. Types of dies – Simple, Compound, Combination and Progressive dies and punches of various press working operations such as punching, blanking, drawing, bending, forming, coining etc. Centre of pressure, different forces, press capacity in tonnage, strip layout, methods of reducing forces. Design guidelines for blanking and progressive die elements (theoretical treatment only)	**CO4**	**(06)**

Note: Additional tutorial of 1 hr/week/batch is to be taken in Time table as per course requirement

Assignments (minimum 5)

1.	Design of different types of jigs for drilling operations.
2.	Design of different types of jigs for reaming operations.
3.	Design of different types of milling fixtures.
4.	Types of drills and reamers.

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5.	Types of milling cutters.
6.	Press tools.
7.	Advanced manufacturing by using CNC.
Text Books	
1.	"*Production Engineering*" by Dr. P.C. Sharma, S. Chand Publication, 11th Edition, 2024 (Unit 1,2,3,6)
2.	"*Production technology*" by R. K. Jain, Khanna Publications,17th edition, Volume I,2011 (Unit 1,2,3,6)
3.	"*Jigs and Fixtures*" by P.H. Joshi, McGraw Hill,3rd Edition, 2017 (Unit 4)
4.	"*Machine Tool Engineering*" by G. R. Nagpal, Khanna Publication, 8th Edition,1999
5.	"*CAD/CAM Principles & Applications*" by P. N. Rao, McGraw Hill Publication, 3rd ed, 2017 (Unit 5)
Reference Books	
1.	**"***Production Technology-HMT*" McGraw-Hill Publication of India,1st edition,2017. (Unit 1,2,3,6)
2.	"*Manufacturing Processes*" by S. E. Rusinoff Times India Press 2nd edition,2015
3.	"*Fundamentals of Tool Design*"Society of manufacturing engineers ,6th edition,2010
4.	"*Tool Design*" by Donaldson, THM Publication, 3rd Edition,1973. (Unit 6)
5.	"*Introduction to Jigs and Fixtures*" by Hoffman, Galgotia Publishers,5th edition,2003 (Unit 4)
Useful Links	
1.	NPTEL Lecture: http://nptel.ac.in/courses/112105126/ https://archive.nptel.ac.in/courses/112/105/112105127/ https://www.youtube.com/watch?v=7yzvno4AvKw

Mapping of COs and POs

PO → CO ↓	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PSO 1	PSO 2	PSO 3
CO 1	3	3	2	-	-	-	-	-	-	-	2	3	2	-
CO 2	3	-	2	2	-	-	-	1	-	-	2	3	3	-
CO 3	3	3	2	2	2	-	-	1	-	-	2	3	3	3
CO 4	3	3	2	2	2	-	-	1	-	-	2	3	3	3

1: Slight(Low) 2: Moderate(Medium) 3: Substantial(High)

Assessment Pattern (with revised Bloom's Taxonomy)

Knowledge Level	MSE	ISE	ESE
Remember	4	4	10
Understand	4	4	-
Apply	4	4	10
Analyse	4	4	20
Evaluate	4	4	20
Create	-	-	-
TOTAL	20	20	60

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Govt. College of Engg., Karad

Government College of Engineering, Karad				
Third Year (Sem – V) B. Tech. Mechanical Engineering				
ME3502 : Heat and Mass Transfer				
Teaching Scheme			**Examination Scheme**	
Lectures	03 Hrs/week		MSE	20
Tutorials	--		ISE	20
Total Credits	03		ESE	60
			Duration of ESE	02 Hrs 30 Min

Prerequisite: Engineering Thermodynamics. Fluid Mechanics.

Course Outcomes (CO): Students will be able to

CO1	Illustrate the fundamental principles/laws of heat transfer and mass transfer
CO2	Understand common engineering processes and significance of different dimensionless numbers related with heat and mass transfer
CO3	Apply skills for modelling and analysing simple heat and mass transfer problems
CO4	Analyse issues in the industries and familiarize with current developments in heat transfer

	Course Contents	CO	Hours
Unit 1	**Introduction to Heat Transfer** Modes andlaws of heat transfer, thermo-physical properties, Electrical Analogy in conduction, derivation of Generalized heat conduction equation in Cartesian coordinates, Fourier, Laplace and Poisson's equation. Generalized heat conduction equation in cylindrical and spherical co-ordinates. (No derivation). Heat pipe and different applications of heat transfer phenomena	**CO1**	**(07)**
Unit 2	**Conduction** Heat conduction through a plane wall, cylindrical wall and sphere. Heat conduction through a composite slab, cylinder and sphere, effect of variable thermal conductivity, critical radius of insulation, Economic insulation, and thermal contact resistance One dimensional steady state heat conduction with heat generation for plane wall, cylinder and sphere. (Basic derivation only) Extended Surfaces: Types and applications of Fins, Heat transfer through extended surfaces. Effectiveness and efficiency of a fin. Unsteady state heat conduction System with negligible internal resistance, Biot and Fourier numbers. Lumped heat capacity method, use of Heisler charts. (No derivation)	**CO2, CO3**	**(08)**
Unit 3	**Convection** Local and average convective coefficient, Hydrodynamic and thermal boundary layer, Laminar and turbulent flow over a flat plate and through a duct, Friction factor Free and Forced Convection Dimensional analysis in free and forced convection, physical significance of the dimensionless numbers related to free and forced convection, empirical correlations for free and forced convection for heat transfer in laminar and turbulent flow over a flat plate	**CO2, CO3**	**(06)**
Unit 4	**Boiling and Condensation** Introduction to Boiling and Condensation, pool boiling, critical heat flux, burnout point, forced boiling. Film and drop wise condensation, determination of heat transfer coefficient, Nusselt's theory of condensation for vertical plate. Heat transfer enhancement techniques-passive and active Introduction of single phase and multiphase flow	**CO2, CO4**	**(05)**
Unit 5	**Radiation** Nature of thermal radiation, absorptivity, reflectivity, transmissivity, emissive power and emissivity, spectral and total concept, blackbody, grey body, and white body Kirchhoff's law, Wien's law and Planck's law, and deduction of Stefan Boltzmann law. Lambert cosine rule, Intensity of radiation. Energy exchange by radiation between two black surfaces with non- absorbing medium in between and in absence of reradiating surfaces. Shape factor and its characteristics. Energy exchange by radiation between two grey surfaces without absorbing medium, concept of radiosity and irradiation, radiation shields	**CO2, CO3**	**(06)**

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Unit 6	**Heat Exchangers, Phase Change and Mass Transfer Phenomenon** Heat exchangers classification, overall heat transfer coefficient, heat exchanger analysis, use of log mean temperature difference (LMTD) for parallel and counter flow heat exchangers, LMTD correction factor, fouling factor, The effectiveness-NTU method for parallel and counter flow heat exchangers. Design considerations of heat exchanger, compact heat exchangers **Mass transfer:** Introduction of mass transfer, analogy with Heat transfer, Fick's law, diffusion and total molar flux (Descriptive treatment only)	CO2, CO4	(08)

Text Books	
1.	"*Engineering Heat and Mass Transfer*", Mahesh M. Rathore, Laxmi Publication (P) Ltd, 4th edition 2023
2.	"*Heat Transfer*", J. P. Holman, McGraw Hill Book Company, New York, 10th Edition, 2017. (Unit 1 to 5)
3.	"*Fundamentals of Engineering Heat and Mass Transfer* (SI units)", R.C. Sachdeva, New Age International Publication, 6th Edition, 2022 (Unit 1 to 5)
4.	"A Text Book on *Heat Transfer*", Dr S. P. Sukhatme, Universities Press, 4th Edition, 2005 (Unit 1 to 5)
Reference Books	
1.	"*Heat Transfer – A Practical Approach*", Yunus Cengel, McGraw Hill. 6thEdition,2020 (Unit 1 to 5)
2.	"*Fundamentals of Heat Transfer*" Alan Chapman, Pearson Publication, 4th edition, 2016. (Unit 1 to 5)
3.	"*Fundamentals of Heat and Mass Transfer*", Theodore Bergman, Adrienne Lavine, Frank P.Incropera, David P.Dewitt,John Wiley & sons,8thEdition, 2018 (Unit 6)
Useful Links	
1.	https://archive.nptel.ac.in/courses/112/101/112101097/
2.	https://www.sciencedirect.com/browse/journals-and-books
3.	http://www.thermalfluidscentral.org/e-books
4.	http://www.elsevier.com/books/advances-in-heat-transfer

Mapping of Cos and Pos

PO → CO ↓	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	3	1	1	1	-	-	-	-	-	-	1		1	1	-
CO 3	3	2	2	2	-	-	-	-	-	-	1		1	1	-
CO 4	3	3	3	3	2	2	-	-	-	-	1		2	2	1

1: Slight(Low) 2: Moderate(Medium) 3: Substantial(High)

Assessment Pattern (with revised Bloom's Taxonomy)

Knowledge Level	MSE	ISE	ESE
Remember	4	5	10
Understand	4	5	10
Apply	4	5	10
Analyse	4	5	10
Evaluate	4	-	20
Create	-	-	-
TOTAL	20	20	60

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Government College of Engineering, Karad					
Third Year (Sem – V) B. Tech. Mechanical Engineering					
ME3503: Theory of Machines					
Teaching Scheme			**Examination Scheme**		
Lectures	03 Hrs/week		MSE	20	
Tutorials	--		ISE	20	
Total Credits	03		ESE	60	
			Duration of ESE	03Hrs	

Prerequisite : Nil

Course Outcomes (CO): Students will be able to

CO1	Explain and apply fundamental principles of kinematics and dynamics of machines to different mechanisms
CO2	Analyse the given mechanism for velocity & Acceleration of different links
CO3	Apply balancing methods to balance rotating and reciprocating components
CO4	Analyze vibrations of single degree of freedom systems

	Course Contents	CO	Hours
Unit 1	**Fundamentals of Mechanisms** Links, kinematic pair , Kinematic chain, Mechanism, inversion, Types of constraints, Grubbler's criterion, Grashof's Criterion for mobility, Inversions of slider crank chain, Double slider crank chain, Four bar mechanism.	**CO1**	**(06)**
Unit 2	**Velocity of Mechanism** Graphical analysis of Velocity of different mechanisms using relative velocity method, Klein's construction for slider crank mechanism,Instantaneous centre and analytical method.	**CO2**	**(06)**
Unit 3	**Acceleration of Mechanism** Graphical analysis of acceleration for different mechanisms using relative velocity method, Corioli's component of acceleration, Klein's construction	**CO1**	**(06)**
Unit 4	**Introduction to Gearing systems** Gear geometry nomenclature, types of gear profile- involute and cycloidal, theory of spur gear, interference in involute tooth gears, hunting gear set. Types of gear trains – simple, compound, reverted, epicyclic gear train, tabular method for finding the speeds of elements in epicyclic gear train, torques in epicyclic gear train	**CO3**	**(07)**
Unit 5	**Balancing** Static and dynamic balancing of rotary and reciprocating masses, primary and secondary forces and couples. Direct and reverse cranks, balancing of single cylinder, multi cylinder, In-line engines for four wheeler	**CO4**	**(07)**
Unit 6	**Mechanical Vibrations** Basic concepts and definitions, types of vibrations, equivalent springs, equation of motion, types of damping, SDOF free vibrations with and without damping, logarithmic decrement. SDOF forced vibrations with and without damping, magnification factor, frequency response curves, vibration isolation and transmissibility	**CO1**	**(08)**

Text Books

1. *"Theory of Machines"*, Rattan S. S, Tata McGraw Hill, New Delhi, 5th edition, 2019. (Unit 1 to 3)
2. *"Theory of Machine And Mechanisms"*, J. E. Shigley, Oxford University Press, 4th ed, 2014 (Unit 1 to 5)

Reference Books

1. *"Kinematics & Dynamics of Machinery"*, Norton, McGraw Hill, New York, 3rd edition, 2017
2. *"Theory of Machines"*, Thomas Bevan, Pearson Education India, 3rd edition, 2009. (Unit 1 to 3)
3. *"Mechanical Vibrations"*, S. S. Rao, Pearson Education, 6th edition, 2017. (Unit 6)

Useful Links

1. https://nptel.ac.in/courses/112107212
2. https://nptel.ac.in/courses/112104121
3. https://archive.nptel.ac.in/courses/112/104/112104114/

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CO 1	3	3	3	1	-	-	-	-	-	-	1	2	2	1
CO 2	2	2	1	1	-	-	-	-	-	-	1	1	1	1
CO 3	2	2	3	1	-	-	-	-	-	-	1	2	-	1
CO 4	2	2	2	1	-	-	-	-	-	-	1	2	-	1

1: Slight(Low) 2: Moderate(Medium) 3: Substantial(High)

Assessment Pattern (with revised Bloom's Taxonomy)

Knowledge Level	MSE	ISE	ESE
Remember	-	-	-
Understand	5	5	10
Apply	5	5	10
Analyse	5	5	20
Evaluate	5	5	20
Create	-	-	-
TOTAL	20	20	60

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Government College of Engineering, Karad					
Third Year (Sem – V) B. Tech. Mechanical Engineering					
ME3514: Renewable Energy Engineering (Program Elective-01)					
Teaching Scheme			**Examination Scheme**		
Lectures	03Hrs/week		MSE	20	
Tutorials	--		ISE	20	
Total Credits	03		ESE	60	
			Duration of ESE	02 Hrs 30 Min	

Prerequisite : Engineering Thermodynamics

Course Outcomes (CO): Students will be able to

CO1	Identify renewable energies scenario
CO2	Analyse the performance of various solar systems.
CO3	Understand the potential of wind energy conversion systems and Biomass energy.
CO4	Illustrate Bio energy, Wave energy, Ocean energy and Geothermal Energy

	Course Contents	CO	Hours
Unit 1	**Scenario of renewable energy engineering :** Differentiation between renewable and non-renewable energy, Need of renewable energy, Advantages and disadvantages of renewable energy, present energy scenario of renewable and conventional energy in world and in India.	**CO1**	**(03)**
Unit 2	**Solar Radiation and its Measurement** Solar Radiation- The Sun as the source of Radiation, Earth and Solar constant basic, Spectrum distribution of extra-terrestrial radiations and its variation, Basic Earth Sun angle, Solar time and equation of time, Depletion of Solar radiation by the atmosphere, Computation of radiation on inclined surfaces, Solar charts, Measurements of diffuse & global & direct radiations, Duration of sunshine hours.	**CO2**	**(08)**
Unit 3	**Solar Energy Applications** Application of Solar energy in heating, cooling, pumping, power production, distillation, drying, solar cookers, solar pond, solar furnaces **Solar Photovoltaic**- Introduction, Fundamentals of Photovoltaic conversion, PV systems - Stand alone, Grid connected and Solar power satellite energy, Photo-cell materials, Cell module array, Series and parallel connections, Maximum power point tracking **Solar Energy Collector** - Flat plate collector, Transmissivity of cover plate, Energy balance equation and Collector efficiency, concentrating collector, Comparison of Flat plate and concentrating collector	**CO2**	**(08)**
Unit 4	**Wind Energy** Nature of wind energy, Data collection and site selection, Basic components of a WECs, Classification of WEC system, Vertical axis wind turbine, Horizontal axis wind turbine, Rotor design, Blade design, Forces on blade, Horizontal axis wind turbine theory, Slip stream theory, Applications of wind energy. (No numerical)	**CO3**	**(06)**
Unit 5	**Biomass energy** Introduction, Biomass conversion Technologies, Photosynthesis, Biogas generation, Factors affecting Bio-digestion of gas, **Bio gas** Chemistry of biogas generation variables affecting simple gas plants, types of digesters their working and construction, application of biogas, use of bio-gas, case study of 'Pura' village bio gas electricity generation.	**CO3**	**(07)**
Unit 6	**Geothermal Energy** Sources, application of geothermal energy, various types of geothermal power plants. **Tidal Energy**Tidal energy available in India, suitable locations, study of various tidal energy power plants, and characteristics of turbines required. **Wave Energy** Introduction to Wave Energy, Phenomenon of wave generation. **Energy audit and Management** –Introduction, need and procedure.	**CO4**	**(08)**

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Text Books	
1.	"*Solar Energy*" by S. P. Sukhatme and J. K. Nayak, Tata McGraw-Hill, 4th Edition, 2017. (Unit 1,2,3)
2.	"*Non-Conventional Energy Sources*" G. D. Rai, Khanna Publisher, 6th Edition, 2017. (Unit 4,5,6)
3.	"*Non-Conventional Resources of Energy*" by G. S. Sawhney, PHI, 4th Edition, 2012. (Unit 4,5,6)
Reference Books	
1.	"*Solar Energy*" by S H P Garg and J Prakash, Tata McGraw-Hill, 1st revised edition, 2017. (Unit 1,2,3)
2.	"*Non-conventional energy resources*" by Shobh Nath Singh, , Pearson Education India,1st Edition, 2015
3.	"*Fundamental and application of renewable energy*" by Yunus. A. Cengel, John M. Cimbala, McGraw-Hill, 1st edition, 2020. (Unit 4,5,6)
Useful Links	
1.	https://www.youtube.com/watch?v=mh51mAUexK4&list=PLwdnzlV3ogoXUifhvYB65lLJCZ74o_fAk
2.	www.ises.org
3.	http://www.awea.org
4.	https://www.nrel.gov

Mapping of COs and POs

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CO 1	1	1	1	1	-	2	-	-	-	-	2	1	1	2
CO 2	2	2	2	1	-	2	-	-	-	-	2	1	1	2
CO 3	2	2	2	1	-	2	-	-	-	-	2	1	1	2
CO 4	2	2	2	1	-	2	-	-	-	-	2	1	1	2

1: Slight(Low) 2: Moderate(Medium) 3: Substantial(High)

Assessment Pattern (with revised Bloom's Taxonomy)

Knowledge Level	MSE	ISE	ESE
Remember	5	5	10
Understand	5	5	10
Apply	5	5	10
Analyse	5	5	10
Evaluate	-	-	10
Create	-	-	-
TOTAL	20	20	60

Government College of Engineering, Karad

Third Year (Sem – V) B. Tech. Mechanical Engineering

ME 3524: Industrial Instrumentation (Program Elective-01)

Teaching Scheme			**Examination Scheme**	
Lectures	03 Hrs/Week		MSE	20
Tutorials	--		ISE	20
Total Credits	03		ESE	60
			Duration of ESE	02:30Hrs

Prerequisite: Nil

Course outcomes: Students will be able to

1. Understand the elements of generalized measurement system and its performance characteristics.
2. Apply suitable temperature, pressure, force and torque measuring instruments for given application
3. Select appropriate velocity, acceleration, flow, and level measuring instruments for given application
4. Apply suitable viscosity, moisture and humidity measurement devices for given application

	Course Contents	**CO**	**Hrs**
Unit 1	**Introduction to Instrumentation System:** Typical applications on Instrument systems, Methods of measurements, functional elements of a measurement system, functional elements of instruments, classification of instruments, static and dynamic performance characteristics of instruments, standards and calibration, sensors and transducer elements, Types of errors and uncertainty analysis.	**CO1**	**(06)**
Unit 2	**Temperature and Pressure Measurement:** Temperature scales, Mechanical thermometers-types, Electrical thermometers- types, Mechanical pressure instruments- manometers, elastic type pressure gauges, Electrical methods of pressure measurement, Calibration of temperature and pressure measurement instruments.	**CO1, CO2**	**(07)**
Unit 3	**Force and Torque Measurement** Force (Weight) measurement, Mechanical balances-types, Accelerometer type force measurement, Electromagnetic balance, Mechanical load cells- types, Strain gauge based. Torque measuring instruments: Mechanical, electrical, optical, strain gauge based	**CO1, CO2**	**(07)**
Unit 4	**Velocity and Acceleration Measurement:** Velocity Measurements- Tachometers- types, Contact& noncontact type, Tachometer generator, Speed measuring sensors & pickups. Seismic- acceleration pick-ups-types, LVDT accelerometer, Electrical-resistance strain gauge accelerometer, Piezoelectric accelerometer, Capacitive accelerometer, Servo type accelerometer, angular accelerometer	**CO1, CO3**	**(06)**
Unit 5	**Flow and Level measurement:** Mechanical flow meters-types, Mass flow meters-types, Ultrasonic flowmeters, Anemometers- principle, types, Mechanical anemometer-types, Flow meter calibration.Level measurement- types, Float type level indication, Level measurement-electrical methods, Ultrasonic level sensors, Optical level sensors, Laser level devices.	**CO1, CO3**	**(08)**
Unit 6	**Viscosity, Humidity and Moisture measurement:** Viscosity measurement types, selection of viscometers, Humidity measurement-types, Measurementof moisture in gases and liquids- types of Hygrometers, Measurement of moisture in solids- types of gauges.	**CO1, CO4**	**(06)**

Text Books

1. *"Mechanical Measurement and Control"* by D.S. Kumar, Metropolitan Book Co. Pvt. Ltd., New Delhi, 5th Edition, 2012. (Unit 1 to 6)
2. *"Instrumentation Measurement and Analysis"* byB. C. Nakra, K. K. Chaudhary, McGraw Hill, New Delhi, 4th Edition, 2016. (Unit 1)
3. *"Industrial Control & Instrumentation"* byW. Bolton, Orient Longman Limited, 3rdEd, 1991. (Unit 1,4)
4. *"Industrial Instrumentation and Control"* by S. K. Singh, Tata McGraw Hill, 3rd Edition, 2010

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Reference Books	
1.	"*Mechanical Measurement*" by Beckwith and Buck, Pearson Education Asia, 6th Edition, 2013
2.	"*Measurement Systems*" by Doebelin Ernest O, Dhanesh Manik, McGraw Hill International Publication Co. New York, 6th Edition, 2017.
3.	"*Industrial Instrumentation*" by K. Krishnaswamy, S. Vijayachitra, New Age International Publishers, 2nd Edition, 2020.
4.	"*Theory and Design for Mechanical Measurements*" by Richard S. Figliola, Donald E. Beasley, Wiley India, 6th Edition, 2014.
Useful Links	
1.	https://archive.nptel.ac.in/courses/112/107/112107242/
2.	https://onlinecourses.nptel.ac.in/noc23_me09/preview
3.	https://onlinecourses.nptel.ac.in/noc23_me09/preview

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CO 2	3	2	2	-	1	-	-	-	-	-	2	3	2	3
CO 3	3	2	2	-	2	-	-	-	-	-	2	3	2	3
CO 4	3	2	1	-	2	-	-	-	-	-	2	3	2	3

1: Slight(Low) 2: Moderate(Medium) 3: Substantial(High)

Assessment Pattern (with revised Bloom's Taxonomy)

Knowledge Level	MSE	ISE	ESE
Remember	5	4	20
Understand	5	4	10
Apply	5	4	10
Analyse	-	4	10
Evaluate	5	4	10
Create	-	-	-
TOTAL	20	20	60

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Mechanical Engineering Dept.
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Government College of Engineering, Karad				
Third Year (Sem–V) B.Tech. Mechanical Engineering				
ME3534: Internal Combustion Engines (Program Elective-01)				
Teaching Scheme			**Examination Scheme**	
Lectures	03Hrs/week		MSE	20
Tutorials	--		ISE	20
Total Credits	03		ESE	60
			Duration of ESE	02 Hrs 30 Min

Prerequisite : Thermodynamics, Heat and Mass transfer

Course Outcomes (CO): Students will be able to

CO1	Comprehend constructional details and various types of internal combustion engine
CO2	Understand and analyze basic thermodynamic cycles for I.C. engines
CO3	Comprehend combustion phenomenon and emission control in S.I. engine and C.I. engines
CO4	Analyze various engine parameters, performance characteristics and various engine system

	Course Contents	CO	Hours
Unit 1	**Introduction** to I.C. engine, classification and applications, valve timing diagrams, port timing diagrams, power transmitting components, Six stroke engine, I.C. engine cycles: Air standard cycles- Otto, Diesel (Numerical Treatment) and Dual cycle(No numerical Treatment), fuel-air cycles, assumptions, actual cycles-Time loss, heat loss and exhaust blow down losses	**CO1 CO2**	**(07)**
Unit 2	**Fuel Systems for S.I. Engines:** Engine fuel requirements, Introduction to carburettor, effect of altitude. Electronic petrol injection systems types of MPFI systems, sensors, ECU merits and demerits **Fundamentals of Combustion in S.I. Engines:** Stages of combustion in S.I. engine, factors affecting flame speed, abnormal combustion, influence of engine design and operating variables on detonation, fuel rating, Octane number, fuel additives, HUCR, combustion chambers of S.I. engines.	**CO3**	**(07)**
Unit 3	**Fuel Systems for C.I. Engines:** Requirements of injection system, types of injection systems – Individual pump, common rail and distributor systems, unit injector, Types of fuel nozzles- single hole, multi hole, pintle, and pintaux, formation of spray, Electronic diesel injection system **Fundamentals of Combustion in C.I. Engines**: Stages of combustion in C.I. engine, factors affecting delay period, abnormal combustion - diesel knock, influence of engine design and operating variables on diesel knock, comparison of abnormal combustion in S.I. and C.I. engines, Cetane number, additives, types of combustion chambers.	**CO3**	**(08)**
Unit 4	**Performance Testing of Engines:** Determination of fuel consumption, air consumption, air-fuel ratio, torque, brake power, indicated power, friction power, brake thermal efficiency, mechanical efficiency, Volumetric efficiency and mean effective pressure (MEP), numerical on Heat balance sheet, engine performance and performance curves	**CO4**	**(06)**
Unit 5	**Engine Emission and Control:** S.I. engine emission (HC, CO, NOx) control methods-Evaporative Loss Control Device (ELCD), catalytic converters, C.I. engines emission (HC, CO, NOx, smog, particulate), control methods- chemical, EGR, standard pollution norms like EURO, Bharat stage-VI, alternative fuels, dual-fuel engines, introduction to lubricating and cooling systems. Superchargers, Turbochargers	**CO3 CO4**	**(06)**
Unit 6	**Modern Trends in I.C. Engines:** Advances in valve and valve mechanism e.g. camless engine, Variable Valve Timing (VVT) diagram, advances in S.I. engines: gasoline direct injection system (GDI) components such as sensors, ECU etc., merits and demerits, fuel supply system for LPG/CNG fuels and engines. Recent trends in ignition system e.g. Digital Twin Spark Ignition (DTSI), advances in C.I. engines: Common Rail Direct Injection System (CRDI) components such as sensors, ECU *etc.*, merits and demerits	**CO4**	**(06)**

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Text Books	
1.	"*Internal Combustion Engines*" by V.Ganesan, Tata McGraw-Hill Publishing Company Ltd, 4th Edition, 2017 (Unit 1 to 6)
2.	"*A Course in Internal Combustion Engines*" by M.L. Mathurand ,R.P. Sharma, Dhanpat Rai Publications Pvt. Ltd, 3rd Edition, 2018
3.	"*Internal Combustion Engines*" by R.K. Rajput,LaxmiPublicationsPvt.Ltd,2nd Edition,2007
Reference Books	
1.	"*Internal Combustion Engines and Air Pollution*" by R.Yadav, Central Publishing House, Allahabad, 2nd, 2004
2.	"*Internal Combustion Engine Fundamentals*" by John B. Heywood, Tata Mc Graw-Hill. Publishing Company Ltd, 1st Edition, 2011
3.	"*Automotive Engines*" by Srinivasan, Tata Mc Graw-Hill Publishing Company Ltd.,1st Edition, 2001
4.	"*Internal Combustion Engines*" by Domkundwar and Domkundwar, Dhanpat Rai Pub. Pvt Ltd, 2018
Useful Links	
1.	http://www.iitg.ernet.in/scifac/qip/public_html/cd_cell/internal_combusn_engines.htm
2.	http://vwts.ru/injector/k-jetronic/gasoline_fuel_injection_system_k-jetronic_eng.pdf
3.	www.yildiz.edu.tr/~sandalci/dersnotu/AKTraining.pdf

Mapping of COs and POs

PO → / CO ↓	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PSO 1	PSO 2	PSO 3
CO 1	2	-	-	-	-	1	-	-	-	-	-	-	-	1
CO 2	2	2	2	-	-	1	-	-	-	-	1	-	2	2
CO 3	2	2	2	-	-	1	-	-	-	-	1	1	2	2
CO 4	2	2	2	-	1	-	-	-	-	-	1	1	-	-

1: Slight(Low) 2: Moderate(Medium) 3: Substantial(High)

Assessment Pattern (with revised Bloom's Taxonomy)

KnowledgeLevel	MSE	ISE	ESE
Remember	4	5	10
Understand	4	5	10
Apply	4	5	10
Analyze	4	5	15
Evaluate	4	-	15
Create	-	-	-
TOTAL	20	20	60

Chairman BoS
Mechanical Engineering Dept.
Govt. College of Engg., Karad

Government College of Engineering, Karad				
Third Year (Sem – V) B. Tech. Mechanical Engineering				
ME3544: Turbo Machinery (Program Elective-01)				
Teaching Scheme			**Examination Scheme**	
Lectures	03 Hrs/Week		MSE	20
Tutorials	--		ISE	20
Total Credits	03		ESE	60
			Duration of ESE	02:30Hrs

Prerequisite: Fluid Mechanics

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

1.	Understand the basics of turbo machinery and to draw velocity triangles.
2.	Analyse different parameters for turbo machines
3.	Understand thermodynamics and kinematics behind turbo machines.
4.	Understand the concept of centrifugal and axial compressors.

	Course Contents	CO	Hrs
Unit 1	**Impact of Jet:** Impulse momentum principle and its applications, Force excreted on fixed plate, moving flat plate and curved vanes, series of plates, velocity triangles and their analysis.	**CO1**	**(06)**
Unit 2	**Impulse Water Turbines** Euler's equation for work done in Rotodynamic Machines classification of water turbines, Pelton wheel, its construction and working, velocity triangles. Types, Pelton wheel design. Calculation of efficiency, Power, Discharge etc. Governing of Pelton wheel, Unit quantities, Specific speed of turbine and performance characteristics of turbine	**CO1, CO2, CO3**	**(07)**
Unit 3	**Reaction Water Turbines** Principle of operation, Construction and working of Francis and Kaplan Turbine, Effect of modification of velocity triangles on runner shape, Draft tube, calculation of various efficiencies, Power, Discharge, Blade angles, Runner dimensions *etc*. Governing of Francis and Kaplan turbine. Draft tube-types and analysis. Specific speed of turbine and performance characteristics of turbine.	**CO1, CO2, CO3**	**(07)**
Unit 4	**Centrifugal Pumps** Working principles, Construction, Types, Various heads, Multistage pumps, Velocity triangles, Minimum starting speed, Maximum permissible suction head (MPSH) and Net positive suction head (NPSH). Methods of priming, calculations of efficiencies, Discharge, Blade angles, Head, Power requiredImpeller dimensions etc. Specific speed and performance	**CO1, CO2, CO3**	**(06)**
Unit 5	**Air Compressors** (Review of compressed air applications, classification of compressor) Reciprocating compressors, construction, Work input, Necessity of cooling, Isothermal efficiency, Effect of clearance volume, Volumetric efficiency, construction, Optimum intermediate pressure for minimum work required, After cooler, Problems on single stage single acting compressor.	**CO1, CO4**	**(08)**
Unit 6	**Rotary Air Compressors** (Review of Centrifugal compressor construction and working), Velocity diagram. Theory of operation, losses, Adiabatic efficiency, Pressure coefficient, Slip factor, performance.	**CO1, CO4**	**(06)**

Text Books

1.	"*Theory of Hydraulic Machinery*" by V.P. Vasandani, Khanna Publishers, Delhi 4th Edition, 2010
2.	"*Hydraulics, Fluid Mechanics and Machinery*" by P. N. Modiand S. N. Seth, Standard Book House, New Delhi, 22nd Edition, 2019.
3.	"*Turbomachines*" by B. U. Pai, Wiley India, 3rd Edition, 2013
4.	"*Thermal Turbomachines*" by Dr.Onkar Singh, Wiley India, 2nd Edition, 2022

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Reference Books	
1.	"*Turbines, Compressors & Fans*" by S.M. Yahya, Tata -McGraw Hill, 2017.
2.	"*Hydraulic Machines*" by Dr. J. Lal, Metropolitan Book Co. Pvt. Ltd., Delhi, 6th Edition 2016.
3.	"*Fundamentals of Turbomachinery*" by William W. Perg, John Wiley & Sons. 2007.
Useful Links	
1.	https://www.youtube.com/watch?v=dafjkTM2nlg
2.	https://www.youtube.com/watch?v=fa0zHI6nLUo
3.	https://www.youtube.com/watch?v=ocVzrn4DLj8&t=3s
4.	https://www.youtube.com/watch?v=DlkmkeENGwg

Mapping of COs and Pos

PO → CO ↓	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PSO 1	PSO 2	PSO 3
CO 1	2	3	1		2					2				1
CO 2	2	2	2							2		1	1	
CO 3	3	3	3				2			2		2	2	2
CO 4	3	3			2									

Assessment Pattern: (with revised Bloom's Taxonomy)

KnowledgeLevel	MSE	ISE	ESE
Remember	5	4	20
Understand	5	4	10
Apply	5	4	10
Analyze	-	4	10
Evaluate	5	4	10
Create	-	-	-
TOTAL	20	20	60

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Mechanical Engineering Dept.
Govt. College of Engg., Karad

Government College of Engineering, Karad				
Third Year (Sem – V) B. Tech. Mechanical Engineering				
ME3505: Thermal & Energy Engineering (Multi-disciplinary Minor- 03)				
Teaching Scheme			**Examination Scheme**	
Lectures	03 Hrs/week		MSE	20
Tutorials	--		ISE	20
Total Credits	03		ESE	60
			Duration of ESE	02 Hrs 30 Min

Prerequisite: Physics.

Course Outcomes (CO): Students will be able to

CO1	Illustrate basics of thermodynamics and fundamental concepts
CO2	Understand thermodynamics laws and vapour power cycles
CO3	Explain the concepts energy engineering and different power plants
CO4	Recognize different applications in the field of thermodynamics such as boiler, engines *etc.*

	Course Contents	CO	Hours
Unit 1	**Basic concepts and definitions** Thermodynamic systems, properties, states and processes, point and path function, conservation of mass, steady flow, work and heat, stored energy, transit energy, free expansion, specific heat, heat capacity, sensible and latent heat. Phases of substances, equation of state for gases, liquid and solid.	CO1	(06)
Unit 2	**Laws of Thermodynamics** Zeroth law of thermodynamics, First law of Thermodynamics - Application of first law to steady flow and non-flow processes, limitations of first law (numerical treatment), PMM-I. Second law of Thermodynamics – Statements, Carnot engine, PMM-II	CO1 CO2	(07)
Unit 3	**Vapour Power Cycles** Vapour power cycles Rankine cycle with superheat, reheat and regeneration, Gas power cycles, Air standard Otto, Diesel and Dual cycles-Air standard Brayton cycle, effect of reheat, regeneration and intercooling.(No numerical)	CO1 CO2	(06)
Unit 4	**Renewable Energy sources** Renewable and non-renewable energy sources. Solar energy: Solar flat plate collector, concentric collector – Parabolic and cylindrical, PV cell, solar dryer, solar cooker. Wind energy	CO3	(06)
Unit 5	**Power plants** Study of different power plant -Steam, Geothermal, Wave, Tidal, Hydro power. Bio-gas, Bio-Diesel	CO3	(06)
Unit 6	**Internal and external combustion Engines** I.C engines - : Construction and Working of C.I. and S.I. Engine, Two stroke, Four Stroke advantages and disadvantages, engine components, Air-fuel ratio. Boiler –Function, important terms in boiler, Classification, comparison between water tube and fire tube boilers	CO4	(09)

Text Books

1. *"Engineering Thermodynamics"* by P. K. Nag, Tata McGraw Hill Pub, 6th Ed, 2017 (Unit 1 to 3)
2. *"Thermal Engineering"* by Mahesh M. Rathore, Tata McGraw Hill Pub, 1st Edition, 2010 (Unit 1 to 3)
3. "*Internal Combustion Engine*" by V Ganeshan , Tata McGraw Hill publication, 2015 (Unit 6)
4. "*Solar Energy*" by S. P. Sukhatme and J. K. Nayak, Tata McGraw-Hill, 4th Edition, 2017 (Unit 4)
5. "*Power Plant Engineering*" by R. K. Rajput, Laxmi Publications (P) LTD, 11th Edition, 2020 (Unit 5)

Reference Books

1. "*Engineering Thermodynamics*" by J.B. Jones and Dugan, Prentice–Hall, 1st ed,, 2006. (Unit 1 to 3)
2. "*Thermodynamics-An Engineering Approach*" by Yunus. A. Cengel & Michael. A. Boles, Mc Graw Hill, 9th Edition, 2019. (Unit 1 to 3)

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3.	*"Principles of Refrigeration"* by Roy J. Dossat, Wiley Eastern Limited, New Delhi, 2006. (Unit 3)
4	*"Power Plant Technology"* by M. M. Wakil, Tata McGraw Hill. Int, 2nd Edition, 2010. (Unit 5)
Useful Links	
1.	http://www.nptel.iitm.ac.in/
2.	http://www.ocw.mit.edu/

Mapping of COs and POs

PO → CO ↓	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PSO 1	PSO 2	PSO 3
CO 1	2	1	1	1	-	-	-	-	-	-	1	1	-	1
CO 2	2	2	1	1	-	-	-	-	-	-	1	1	-	1
CO 3	2	2	2	1	-	-	-	-	-	-	1	2	-	2
CO 4	2	2	2	2	-	-	-	-	-	-	1	2	-	2

1: Slight(Low) 2: Moderate(Medium) 3: Substantial(High)

Assessment Pattern (with revised Bloom's Taxonomy)

Knowledge Level	MSE	ISE	ESE
Remember	4	5	10
Understand	8	5	20
Apply	8	5	20
Analyse	-	5	05
Evaluate	-	-	05
Create	-	-	-
TOTAL	20	20	60

Chairman BoS
Mechanical Engineering Dept.
Govt. College of Engg., Karad

Government College of Engineering, Karad				
Third Year (Sem – V) B. Tech Mechanical Engineering				
ME3516: Entrepreneurship Development (Open Elective-03 Offline Mode)				
Teaching Scheme			**Examination Scheme**	
Lectures	02Hrs/week		MSE	20
Tutorials	--		ISE	20
Total Credits	02		ESE	60
			Duration of ESE	02 Hrs 30 Min

Prerequisite : Nil

Course Outcomes (CO): Students will be able to

CO1	Analyzeentrepreneurship fundamentals, ecosystem dynamics, and challenges to evaluate opportunities for new ventures in diverse economic contexts
CO2	Design innovative business ideas using creativity tools and assess their viability through market, technical and financial feasibility analysis
CO3	Develop structured business plans and models (e.g., Business Model Canvas) to communicate value propositions
CO4	Apply ethical, legal, and sustainable practices to manage startup operations, funding strategies, marketing efforts, and scaling challenges

	Course Contents	CO	Hours
Unit 1	**Introduction to Entrepreneurship** Definition, stages, characteristics, and importance of entrepreneurship, Types of entrepreneurs (innovative, imitative, social, serial), Entrepreneurial mindset and traits (creativity, risk-taking, resilience), Role of entrepreneurship in economic development, Key components of the entrepreneurship ecosystem (government, investors, incubators, academia), Challenges faced by entrepreneurs in developing and developed economies	CO1	(08)
Unit 2	**Idea Generation and Opportunity Recognition** Sources of business ideas (market trends, customer needs, technological advancements), Creativity tools (brainstorming, SCAMPER,), Identifying gaps in the market,difference between ideas and opportunities	CO2	(06)
Unit 3	**Business Planning and Model Development** Business plan, Importance and structure of a business plan, Key components (executive summary, market analysis, operations plan, financial plan),Pitching a business plan to stakeholders,Introduction to the Business Model Canvas (BMC),Nine building blocks of BMC (value proposition, customer segments, revenue streams, etc.),Case studies of successful business models	CO3	(08)
Unit 4	**Funding and Financial Management** Bootstrapping, angel investors, venture capital, crowd funding, and government schemes, Equity vs. debt financing, Preparing for investor pitches,Basics of financial statements (income statement, balance sheet, cash flow statement), Break-even analysis and budgeting, Managing cash flow and working capital.	CO1,CO4	(06)
Unit 5	**Marketing and Scaling a Business** Understanding the target market and customer personalities, Digital marketing tools (social media, SEO, content marketing), Building a brand and customer loyalty, Challenges of scaling a business, Franchising, partnerships, and global expansion, Leveraging technology for growth.	CO3, CO4	(06)
Unit 6	**Legal and Ethical Aspects of Entrepreneurship** Business registration and intellectual property rights (patents, trademarks, copyrights),Compliance with taxation and labour laws, Contracts and agreements,Ethical decision-making in business, Corporate Social Responsibility (CSR) and sustainable entrepreneurship	CO2, CO4	(06)

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Text Books	
1.	"*Entrepreneurship: Successfully Launching New Ventures*" by Bruce R. Barringer and R. Duane Ireland, 7th edition, Pearson , 2024
2.	"*Business Model Generation*" by Alexander Osterwalder, John Wiley & Sons, 1st Edition, 2010
3.	"*Venture Deals: Be Smarter Than Your Lawyer and Venture Capitalist*" by Brad Feld and Jason Mendelson, Wiley publication, 4th Edition, 2019
Reference Books	
1.	"*Innovation and Entrepreneurship*" by Peter F. Drucker, Harper Business, 2nd Edition, 2006.
2.	"*The Lean Startup: How Today's Entrepreneurs Use Continuous Innovation to Create Radically Successful Businesses*" by Eric Ries, Crown Publishing Group, 1st Edition, 2011.
Useful Links	
1.	https://onlinecourses.nptel.ac.in/noc21_mg70/preview https://www.youtube.com/playlist?list=PL8dPuuaLjXtNamNKW5qlS-nKgA0on7Qze https://www.youtube.com/watch?v=fAz9pQ8w9aY https://www.slideshare.net/varshanihanthlade/entrepreneurial-development-44786349

Mapping of COs and POs

PO → CO ↓	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PSO 1	PSO 2	PSO 3
CO 1	1	2	2	3	-	3	3	2	3	3	3	3	2	2
CO 2	1	2	2	2	-	3	3	2	3	3	3	3	3	2
CO 3	1	2	1	3	-	2	2	2	3	3	2	3	3	3
CO 4	1	3	2	2	-	2	3	3	2	2	2	3	3	3

1: Slight(Low) 2: Moderate(Medium) 3: Substantial(High)

Assessment Pattern (with revised Bloom's Taxonomy)

Knowledge Level	MSE	ISE	ESE
Remember	4	4	10
Understand	4	4	-
Apply	4	4	10
Analyse	4	4	20
Evaluate	4	4	20
Create	-	-	-
TOTAL	20	20	60

Chairman BoS
Mechanical Engineering Dept.
Govt. College of Engg., Karad

Government College of Engineering, Karad				
Third Year (Sem– V) B.Tech. Mechanical Engineering				
ME3526: Entrepreneurship (Open Elective 03 – Online Mode)				
TeachingScheme			**ExaminationScheme**	
Lectures	-- / 02 Hrs/week		ISE	--
Tutorials	--		MSE	--
TotalCredits	02		ESE	100

Course Outcomes (CO): Students will be able to

CO1	Analyse entrepreneurship fundamentals, ecosystem dynamics, and challenges to evaluate opportunities for new ventures in diverse economic contexts.
CO2	Design innovative business ideas using creativity tools and assess their viability through market, technical and financial feasibility analysis.
CO3	Develop structured business plans and models (e.g., Business Model Canvas) to communicate value propositions
CO4	Apply ethical, legal, and sustainable practices to manage startup operations, funding strategies, marketing efforts, and scaling challenges

CourseContents

- Students should complete the MOOC course certification in the domain of Sensors and Internet of Things and submit a copy of the certificate to Head of Department prior to ESE.

Guidelines:

- Selection of the MOOC course should be with the prior permission of Head of Department
- DurationforcompletionofMOOCcoursecertification isminimum8Weeks.
- Platform:NPTEL or SWYAM only
- Assessment Guideline:- The evaluation of the MOOC Course will be based on at actual score secured by the student in NPTEL or SWAYAM course certification and it will be converted to ESE score.
- If the student unable to submit the NPTEL or SWAYAM completion Certificate, in such cases evaluation will be based on assignment score (60% weightage) of registered NPTEL/SWAYAM and internal evaluation (40 % weightage).
- The rubrics for internal evaluation are given below.

Government College of Engineering, Karad

Department of Mechanical Engineering

A. Y. 20__ - 20__

Course Code : **Assessment Sheet** **Class:**

Course Title :

Sr No.	Reg. No	Name of Student	Course Title	Knowledge of Course (08 Marks)	Communication Skill (08 Marks)	Presentation Skill (08 Marks)	Content (08 Marks)	Q & A (08 Marks)	Total Marks (out of 40)
1									
2									

Faculty Name and Sign. **Head of the Department**

Chairman BoS
Mechanical Engineering Dept.
Govt. College of Engg., Karad

Government College of Engineering, Karad					
Third Year (Sem – V) B. Tech. Mechanical Engineering					
ME3507: Heat and Mass Transfer Lab					
Laboratory Scheme:			**Examination Scheme:**		
Practical	02 Hrs/week		ISE	25	
Total Credits	01		ESE	25	
Prerequisite: Engineering Thermodynamics. Fluid Mechanics.					
Course Outcomes (CO): Students will be able to					
CO1	Understand and execute fundamental of heat transfer.				
CO2	Apply different heat transfer processes while experimentation				
CO3	Analyze the data from experiment and correlate to basic				
CO4	Evaluate different parameters manually and using computer software's.				

	Course Contents	CO
Experiment 1	Study and Demonstration of Heat Pipe.	CO1
Experiment 2	Determination of thermal conductivity of Insulating powder.	CO2,CO4
Experiment 3	Determination of thermal conductivity of a Metal rod.	CO2, CO4
Experiment 4	Determination of thermal resistance and temperature distribution in a Composite wall.	CO2, CO4
Experiment 5	Determination of local and average heat transfer coefficient in Natural convection heat transfer from a vertical cylinder	CO3
Experiment 6	Determination of Heat Transfer Coefficient under forced convection to air from a hot pipe.	CO3
Experiment 7	Determination of emissivity of a Non-black surface.	CO3, CO4
Experiment 8	Determination of Stefan Boltzmann Constant.	CO3, CO4
Experiment 9	Determination of Critical Heat Flux.	CO3
Experiment 10	Determination of heat transfer coefficient in dropwise and film wise condensation	CO4
Experiment 11	Determination of overall heat transfer coefficient and effectiveness in a Parallel flow and Counter flow Heat Exchanger.	CO4
Experiment 12	To prepare a program in C or C++ for 2 experimental results	CO4
Experiment 13	To simulate 2D heat conduction problem of Laplace using excel	CO4
List of Submission: Minimum number of Experiments : Any 10 from above		

Mapping of COs and POs

PO → / CO ↓	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PSO 1	PSO 2	PSO 3
CO 1	2	1	1	2	-	-	-	2	2	-	-	2	2	1
CO 2	2	2	2	2	-	-	-	2	2	-	-	2	2	1
CO 3	2	2	3	3	-	-	-	2	2	-	-	2	2	2
CO 4	2	2	3	3	2	-	-	2	2	-	-	2	2	2

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Assessment Pattern:

Skill Level (as per CAS Sheet)	Exp 1	Exp 2	Exp 3	Exp 4	Exp 5	Exp 6	Exp 7	Exp 8	Exp 9	Exp10	Avg
Task I	15	15	15	15	15	15	15	15	15	15	15
Task II	05	05	05	05	05	05	05	05	05	05	05
Task III	05	05	05	05	05	05	05	05	05	05	05
ISE	25	25	25	25	25	25	25	25	25	25	25

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Mechanical Engineering Dept.
Govt. College of Engg., Karad

Government College of Engineering, Karad				
Third Year (Sem – V) B. Tech. Mechanical Engineering				
ME3508: Theory of Machines Lab				
Laboratory Scheme:			**Examination Scheme:**	
Practical	02 Hrs/week		ISE	25
Total Credits	01		ESE	-

Course Outcomes (CO): Students will be able to

CO1	Apply fundamental principles of dynamics to different mechanism
CO2	Analyze the gear and gear trains
CO3	Analyze the balancing of rotating and reciprocating machine elements
CO4	Demonstrate the vibrational behavior of system

Course Contents		CO
Experiment 1	Study of various types of mechanisms	**CO1**
Experiment 2	Draw velocity diagram for a mechanism	**CO1**
Experiment 3	Draw acceleration diagram for a mechanism	**CO1**
Experiment 4	Determine Coriolis Component of acceleration	**CO2**
Experiment 5	Demonstration and study of the gear box of any four wheelers with respect to types of gear, velocity ratio, type of train, arrangement of gears	**CO2**
Experiment 6	Experiment on torque measurement in epicyclic gear train	**CO3**
Experiment 7	Experiment on balancing of rotary masses (static and dynamic)	**CO3**
Experiment 8	Study of balancing of reciprocating masses (draw solution on half imperial size drawing sheets)	**CO4**
Experiment 9	Study of vibration measuring instruments	**CO1**
Experiment 10	Determination of critical speeds of shaft	**CO4**
Experiment 11	Industrial visit to correlate practical applications of the gearbox / balancing of machine / vibration	**CO2** **CO4**
Experiment 12	Demonstration of spectral response of vibrating machine.	**CO4**

List of Submission: Minimum 10 experiments of the above

Mapping of COs and POs

PO → CO ↓	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PSO 1	PSO 2	PSO 3
CO 1	3	2	-	2	-	-	-	1	-	-	1	1	1	1
CO 2	2	2	-	2	-	-	-	1	-	-	1	1	1	1
CO 3	2	2	-	2	-	-	-	1	-	-	1	1	1	1
CO 4	2	2	-	2	-	-	-	1	-	-	1	1	1	1

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Assessment Pattern:

Skill Level (as per CAS Sheet)	Exp 1	Exp 2	Exp 3	Exp 4	Exp 5	Exp 6	Exp 7	Exp 8	Exp 9	Exp10	Avg
Task I	15	15	15	15	15	15	15	15	15	15	15
Task II	05	05	05	05	05	05	05	05	05	05	05
Task III	05	05	05	05	05	05	05	05	05	05	05
ISE	25	25	25	25	25	25	25	25	25	25	25

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Mechanical Engineering Dept.
Govt. College of Engg., Karad

Government College of Engineering, Karad				
Third Year (Sem – V) B. Tech. Mechanical Engineering				
ME3519: Renewable Energy Engineering Lab (Program Elective-01 Lab)				
Laboratory Scheme:			**Examination Scheme:**	
Practical	02 Hrs/week		ISE	25
Total Credits	01		ESE	-

Prerequisite : Engineering Thermodynamics. Fluid Mechanics.

Course Outcomes (CO): Students will be able to

CO1	Understand and execute fundamental of renewable energy engineering.
CO2	Apply and analyse different solar energy parameters.
CO3	Illustrate and demonstration of wind and biogas energy
CO4	Analysis of energy by conducting energy audit.

	Course Contents	CO
Experiment 1	Study and Demonstration of Solar water heater system.	CO1,CO2
Experiment 2	Study and Demonstration of Solar concentrating collector.	CO1, CO2
Experiment 3	Identifying and measuring the parameters of a solar PV module.	CO1, CO2
Experiment 4	Efficiency measurement of standalone Solar PV system.	CO1, CO2
Experiment 5	Demonstration and measurement of solar radiation using pyranometer	CO1, CO2
Experiment 6	Demonstration and measurement of solar radiation using pyrheliometer.	CO1, CO2
Experiment 7	Study and demonstration of wind turbine.	CO1, CO3
Experiment 8	Study and demonstration of biogas plant	CO1, CO3
Experiment 9	Study of Indian electricity grid code 2003 and its amendments	CO1
Experiment 10	Energy Audit – Case Study of an organization.	CO1, CO4
Experiment 11	Industrial visit to renewable energy plant such as solar or biogas.	CO1, CO2, CO3
Experiment 12	Visit to Wind power farm with detailed report	CO1, CO3

List of Submission: Minimum number of Experiments : Any 10 from above

Mapping of COs and POs

PO → CO ↓	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PSO 1	PSO 2	PSO 3
CO 1	1	1	1	1	-	2	-	2	2	-	-	2	2	2
CO 2	2	2	3	2	-	2	-	2	2	-	-	2	2	2
CO 3	2	2	3	3	-	2	-	2	2	-	-	2	2	2
CO 4	2	2	3	3	-	2	-	2	2	-	-	2	2	2

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Assessment Pattern:

Skill Level (as per CAS Sheet)	Exp 1	Exp 2	Exp 3	Exp 4	Exp 5	Exp 6	Exp 7	Exp 8	Exp 9	Exp10	Avg
Task I	15	15	15	15	15	15	15	15	15	15	15
Task II	05	05	05	05	05	05	05	05	05	05	05
Task III	05	05	05	05	05	05	05	05	05	05	05
ISE	25	25	25	25	25	25	25	25	25	25	25

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Government College of Engineering, Karad				
Third Year (Sem – V) B. Tech. Mechanical Engineering				
ME3529: Industrial Instrumentation Lab (Program Elective-01 Lab)				
Laboratory Scheme:			**Examination Scheme:**	
Practical	02 Hrs/week		ISE	25
Total Credits	01		ESE	-

Prerequisite : Nil

Course Outcomes (CO): Students will be able to

CO1	Understand sensor / transducers in generalized measurement systems
CO2	Select appropriate sensor / transducer based on comparative performance characteristics
CO3	Understand working principle of various sensors and transducers
CO4	Perform measurement of various physical process parameters

	Course Contents	CO
Experiment 1	Study of Generalized Measurement System	**CO1**
Experiment 2	Study of sensors and transducers	**CO1,2**
Experiment 3	Study of static and dynamic characteristics of instruments	**CO3,4**
Experiment 4	Performance on temperature measuring sensors and transducers (Thermocouple / RTD)	**CO3,4**
Experiment 5	Performance on pressure and vacuum measuring sensors and instruments	**CO3,4**
Experiment 6	Performance on fluid flow measuring sensors and instruments	**CO3,4**
Experiment 7	Performance on speed measuring sensors and instruments	**CO3,4**
Experiment 8	Performance on fluid level measuring sensors and instruments	**CO3,4**
Experiment 9	Performance of acceleration and vibration measuring sensors and instruments.	**CO3,4**
Experiment 10	Performance on viscosity measurement	**CO3,4**
Experiment 11	Performance of humidity measuring sensors and instruments.	**CO3,4**
Experiment 12	Performance on Noise measurement using Sound Level meter	**CO3,4**
List of Submission: Minimum number of Experiments : Any 10 from above		

Mapping of COs and POs

PO → CO ↓	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PSO 1	PSO 2	PSO 3
CO 1	3	2	2	1				2		2		2	1	
CO 2	3	2	3	2	2			2		2		2	1	
CO 3	3	3	3	3	2			3	2	2	3	3	3	2
CO 4	2	3	3	3	3			3	3	3	2	3	3	2

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Assessment Pattern:

Skill Level (as per CAS Sheet)	Exp 1	Exp 2	Exp 3	Exp 4	Exp 5	Exp 6	Exp 7	Exp 8	Exp 9	Exp10	Avg
Task I	15	15	15	15	15	15	15	15	15	15	15
Task II	05	05	05	05	05	05	05	05	05	05	05
Task III	05	05	05	05	05	05	05	05	05	05	05
ISE	25	25	25	25	25	25	25	25	25	25	25

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Government College of Engineering, Karad				
Third Year (Sem–V) B.Tech. Mechanical Engineering				
ME3539: Internal Combustion Engines Laboratory (Program Elective-01 Lab)				
Laboratory Scheme:			**Examination Scheme:**	
Practical	02 Hrs/week		ISE	25
Total Credits	01		ESE	-

Prerequisite : Internal Combustion engines

Course Outcomes (CO): Students will be able to

CO1	Study constructional details and various types of internal combustion ngines
CO2	Understand various engine systems
CO3	Understand fuel injection in S.I. engine and C.I. engines
CO4	Impart knowledge about various engine performance characteristics and its testing

Course Contents		CO
Experiment 1	Demonstration of constructional detail of I.C. Engines by dismantling and assembly	**CO1**
Experiment 2	Demonstration of engine systems: Air intake, exhaust, cooling, lubrication systems	**CO2**
Experiment 3	Demonstration of ignition systems, starting systems	**CO2**
Experiment 4	Demonstration of carburetor and petrol injection system	**CO3**
Experiment 5	Demonstration of CRDI	**CO3**
Experiment 6	Experiment on diesel engine to determine variable load performance and heat balance sheet	**CO4**
Experiment 7	Experiment on petrol engine to determine variable load performance and heat balance sheet	**CO4**
Experiment 8	Morse test on multi cylinder petrol engine to determine Indicated Power of each cylinder	**CO4**
Experiment 9	Test on computer controlled I.C. Engine to plot pressure versus crank angle (P-θ) diagram	**CO4**
Experiment 10	Measurement of exhaust emissions of S.I. engine / C.I. engine	**CO4**
Experiment 11	Test on variable compression ratio engine to plot performance curves of engine	**CO4**
Experiment 12	Survey of commercial engines, their specifications, details and troubleshooting	**CO4**
Experiment 13	Visit to an engine manufacturing company / service station	**CO1**

List of Submission: Minimum 10 experiments from above

Mapping of COs and POs

PO → CO ↓	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PSO 1	PSO 2	PSO 3
CO 1	2	-	-	-	-	-	-	2	-	-	-	1	-	-
CO 2	2	2	2	-	-	-	-	1	1	-	1	-	1	-
CO 3	2	2	2	-	-	-	-	1	1	-	1	-	1	-
CO 4	2	2	-	1	-	-	-	2	1	-	1	-	1	-

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Assessment Pattern:

Skill Level (as per CAS Sheet)	Exp 1	Exp 2	Exp 3	Exp 4	Exp 5	Exp 6	Exp 7	Exp 8	Exp 9	Exp10	Avg
Task I	15	15	15	15	15	15	15	15	15	15	15
Task II	05	05	05	05	05	05	05	05	05	05	05
Task III	05	05	05	05	05	05	05	05	05	05	05
ISE	25	25	25	25	25	25	25	25	25	25	25

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Government College of Engineering, Karad				
Third Year (Sem – V) B. Tech. Mechanical Engineering				
ME3549: Turbo Machinery Lab (Program Elective-01 Lab)				
Laboratory Scheme:			**Examination Scheme:**	
Practical	02 Hrs/week		ISE	25
Total Credits	01		ESE	-

Prerequisite : Nil

Course Outcomes (CO): Students will be able to

CO1	Conduct trial & Calculate performance parameters of different turbo machinery.
CO2	Draw & compare performance characteristics curves with their theoretical nature of different turbo machinery
CO3	Explain construction & working of different types of pumps.
CO4	Explain construction & working of various hydraulic devices.

Course Contents		CO
Experiment 1	Study and draw velocity triangles for turbo machines.	CO1,2
Experiment 2	Study and trial on Pelton wheel and plotting of main / operating characteristics	CO1,2
Experiment 3	Study and trial on any one reaction turbine and plotting of main/operating characteristics.	CO1,2
Experiment 4	Study and trial on centrifugal pump and plotting of operating characteristics	CO1,2
Experiment 5	Study and trial on Two stage reciprocating compressor	
Experiment 6	Study of centrifugal blower and hydraulic ram	
Experiment 7	Study of hydraulic devices-Intensifier, Accumulator, Hydraulic jacks, Press, Crane.	CO4
Experiment 8	Study of other types of pumps-Gear pump, Jet pump, Submersible pump, Air lift pump.	CO3
Experiment 9	Industrial visit to Pump/Turbine Manufacturing Industry or Hydro Power Plant.	CO1, 2, 3, 4
Experiment 10	Case study: Collection of detailed technical information on any one of the hydroelectric power plant in India	CO3, 4
Experiment 11	Study of recent advancements in hydro power generation technology	CO3, 4

List of Submission: Minimum 10 experiments from above

Mapping of COs and POs

PO → CO ↓	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PSO 1	PSO 2	PSO 3
CO 1	3	2	2							2			1	
CO 2	3				2		2			2		2	1	2
CO 3	3								2		3			
CO 4									2		2			

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Assessment Pattern:

Skill Level (as per CAS Sheet)	Exp 1	Exp 2	Exp 3	Exp 4	Exp 5	Exp 6	Exp 7	Exp 8	Exp 9	Exp10	Avg
Task I	15	15	15	15	15	15	15	15	15	15	15
Task II	05	05	05	05	05	05	05	05	05	05	05
Task III	05	05	05	05	05	05	05	05	05	05	05
ISE	25	25	25	25	25	25	25	25	25	25	25

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Government College of Engineering, Karad					
Third Year (Sem – V) B. Tech. Mechanical Engineering					
ME3510: Mechanical Engineering Lab (Multi-disciplinary Minor-03 Lab)					
Laboratory Scheme:			**Examination Scheme:**		
Practical	02 Hrs./week		ISE	50	
Total Credits	01		ESE	-	
Prerequisite: Basic Mathematics, Applied Physics.					
Course Outcomes (CO): Students will be able to					
CO1	Develop skills to perform accurate linear and angular measurements using precision instruments.				
CO2	Analyse material properties through tensile and hardness tests on various materials.				
CO3	Understand the working principles of mechanical systems, renewable energy, and thermal applications.				
CO4	Understand the elements of mechatronics system				

Course Contents		**CO**
Implementation of following concepts		
Experiment 1	To perform Linear measurement by using Slip gauge accessories.	**CO1**
Experiment 2	Study and performance on angular measuring instruments. i.e. Bevel Protractor & Sine bar	**CO1**
Experiment 3	To conduct tensile test on standard samples of M.S/Aluminum and comparison of test results on UTM.	**CO2**
Experiment 4	To conduct Hardness test of various materials – Brinell hardness.	**CO1**
Experiment 5	Study and Demonstration of different types of boilers, its mountings and accessories.	**CO4**
Experiment 6	Study and Demonstration of different chassis layout.	**CO4**
Experiment 7	Study and Demonstration of 2 stroke and 4 stroke IC engine.	**CO4**
Experiment 8	Study and Demonstration of solar water heating system.	**CO4**
Experiment 9	Study and Performance on Different types of Flow measuring instruments.	**CO4**
Experiment 10	Study and demonstration of Electric vehicles.	**CO4**
Experiment 11	Interfacing of Digital and analog sensors with Arduino; IR, Ultrasonic, Thermocouple, Strain gauge module.	**CO4**
Experiment 12	Interfacing of actuators with Arduino: DC motor, servo motor, solenoid.	**CO4**
List of Submission: Minimum 10 experiments from above		

Mapping of COs and POs

PO → CO ↓	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PSO 1	PSO 2	PSO 3
CO 1	3	2	1	2	-	-	-	1	2	2	3	1	2	
CO 2	2	3	2	2	-	1	-	1	-	-	-	2	1	2
CO 3	2	1	3	2	-	-	-	1	2	-	-	1	1	
CO 4	2	3	1	1	-	-	-	2	-	1	1	2	1	

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Assessment Pattern:

Skill Level (as per CAS Sheet)	Exp 1	Exp 2	Exp 3	Exp 4	Exp 5	Exp 6	Exp 7	Exp 8	Exp 9	Exp10	Avg
Task I	30	30	30	30	30	30	30	30	30	30	30
Task II	10	10	10	10	10	10	10	10	10	10	10
Task III	10	10	10	10	10	10	10	10	10	10	10
ISE	50	50	50	50	50	50	50	50	50	50	50

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Government College of Engineering, Karad					
Third Year (Sem – V) B. Tech. Mechanical Engineering					
ME3511: Workshop Practice-IV					
Laboratory Scheme:			**Examination Scheme:**		
Practical	02 Hrs/week		ISE	25	
Total Credits	01		ESE	25	
Prerequisite : Machine Tools & Processes					
Course Outcomes(CO): Student will be able to:					
CO1	Understand & apply use of different accessories like steady rest, four jaw chuck, mandrel *etc.*				
CO2	Understand and perform various machining operations on lathe and milling machine				
CO3	Understand and perform various machining operations such as shaping / planning				
CO4	Demonstrate and performthevariousmachiningoperations using CNC machine				

List of Experiments		CO	Contact Hours
Any five experiments have to be conducted.			
Experiment 1	Demonstrate the use of different lathe accessories like steady rest, four jaw chuck, mandrel etc.	**CO1**	**(4)**
Experiment 2	Manufacturing of Helical gear on conventional milling machine as per the drawing	**CO2**	**(6)**
Experiment 3	Job preparation for eccentric turning for objects like camshaft as per the drawing	**CO1,2**	**(4)**
Experiment 4	Job preparation using external or internal thread cutting on lathe machine as per the drawing.	**CO1,2**	**(4)**
Experiment 5	Job preparation on tapered keyway operation on shaping machine.	**CO3**	**(4)**
Experiment 6	Step turning on CNC lathe machine.	**CO1,4**	**(6)**
Experiment 7	Group activity:- Development of any product e.g.- power transmission assembly by using pair of gear.	**CO1,2, 3,4**	**(6)**

Note:-At the end, the job assessment will be done for 50 marks by the workshop superintendent and will be submitted to course coordinator.

MappingofLOs and POs

PO → CO ↓	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PSO 1	PSO 2	PSO 3
CO 1	3	2	1	2	-	-	-	1	2	2	3	1	2	-
CO 2	2	3	2	2	-	1	-	1	-	-	-	2	1	2
CO 3	2	1	3	2	-	-	-	1	2	-	-	1	1	-
CO 4	2	3	1	1	-	-	-	2	-	1	1	2	1	-

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Assessment Pattern:

Skill Level (as per CAS Sheet)	Exp 1	Exp 2	Exp 3	Exp 4	Exp 5	Avg
Task I	15	15	15	15	15	15
Task II	05	05	05	05	05	05
Task III	05	05	05	05	05	05
ISE	25	25	25	25	25	25

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THIRD YEAR

B.TECH MECHANICAL ENGINEERING

COURSE SYLLABI

FOR

SEMESTER VI

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Government College of Engineering, Karad				
Third Year (Sem – VI) B. Tech. Mechanical Engineering				
ME 3601: Control Engineering				
Teaching Scheme			**Examination Scheme**	
Lectures	03 Hrs/week		MSE	20
Tutorials	--		ISE	20
Total Credits	03		ESE	60
			Duration of ESE	02 Hrs 30 Min

Pre-requisite: Basic Electronics and Electrical, Mathematics III

Course Outcomes (CO)

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

CO1	Understand application-wise components of feedback control systems.
CO2	Apply fundamental laws to develop mathematical models for Linear Time Invariant systems.
CO3	Develop block diagram representation for Mechanical, Electrical, Thermal, Hydraulic, Pneumatic systems.
CO4	Analyse the time domain and frequency domain responses of Linear Time Invariant systems.

	Course Contents	CO	Hours
Unit 1	**Basics of Control Systems:** Background, Definitions, Classification of Control Systems - Natural, Manmade, Combinational, Time Varying and Time-Invariant, Linear and Nonlinear, Lumped Parameter and Distributed Parameter, SISO and MIMO systems, Open Loop and Closed Loop Systems, Real time applications of Open loop and closed loop systems, Comparisons, Position Control System- Servomechanisms, Generalized Control System, Requirements of an Ideal Control Systems, Linearization of Non Linear Functions.	**CO1**	(6)
Unit 2	**Mathematical Model of Control System:** Introduction to mathematical modelling, Forms of mathematical model, Concept of transfer function applied to Mechanical Translational/ Rotational Systems, Electrical Systems. Equivalent Mechanical System –Node Basis, Grounded Chair Representation, Analogous Systems- FV and FI analogy.	**CO1 CO2**	(8)
Unit 3	**Block Diagram Representation of Control System Components:** Block diagrams, Block Diagram Algebra, Rules for Reduction of Block Diagrams, Block diagram development from system equations, Block diagram development of system components- Thermometer, Water heating system, Liquid Level Systems, Hydraulic actuator, pneumatic actuator, Hydraulic servomotor, Jet-pipe amplifier, Pneumatic amplifier.	**CO1 CO3**	(7)
Unit 4	**Time Domain Analysis:** Importance of Transient response analysis, Standard Test signals- Step, Ramp, Parabolic, Impulse, Exponential, Sinusoidal, Concept of Poles and Zeros, Distinct, Repeated and Complex Poles. Response of First and Second Order Systems to Inputs -Step, Ramp and Impulse, Damping Ratio and Natural Frequency, Transient Response Specifications.	**CO4**	(7)
Unit 5	**State Space Analysis:** System Representation in Time and Laplace Domain, Modelling of Electrical and Mechanical Systems, Construction of Simulation diagrams, Transfer function from state space model using series programming.	**CO2 CO3**	(7)
Unit 6	**Frequency Response Analysis:** Frequency Domain approach, Magnitude Plots and Phase angle Plots, Bode plots, Gain Margin, Phase Margin, Polar Plots and Stability Determination.	**CO4**	(5)

Text Books

1. "*Control System Engineering*", R. Anandanatarajan, P. Ramesh Babu, SciTech (India) Publication, 5th revised Edition, 2018, ISBN: 9385983571 (Unit 1 to 6)
2. "*Control Systems*", A. Anand Kumar, Prentice Hall (India) Publication 2nd Edition, 2012, ISBN: 9788120349391 (Unit 1 to 6)
3. "*Modern Control Systems*", Katsuhiko Ogata, Pearson Education India, 5th Edition, 2015, ISBN:

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	9789332550162 (Unit 1 to 6)
4.	"*Control Systems Engineering*" I J Nagrath, M. Gopal, New Age International Publication, 7th Edition, 2021, ISBN: 9788195175581 (Unit 1 to 6)
5.	"*Automatic Control Engineering*", D. Roy and Choudhari, Prentice Hall (India) Publication, Standard Edition, 2005, ISBN: 8120321960 (Unit 1,2,3,4)
Reference Books	
1.	"*Automatic Control Engineering*", Francis. H. Raven, Tata McGraw Hill Publication, 5th Edition, 1995 ISBN: 0070855943 (Unit 1,2,3)
2.	"*Automatic Control Systems*", Benjamin. C. Kuo, Willey India Ltd. Publication, 9th Edition, 2014, ISBN: 9788126552337 (Unit 1,2,3,4)
3.	"*Control System Analysis and Design*", A. K. Tripathi, Dinesh Chandra, New Age International Publishers, 2nd Edition, 2015, ISBN: 8122438857 (Unit 1,2,6)
4.	"*Modern Control Systems*", Richard. C. Dorf, Robert H. Bishop, Pearson Publication, 14th Edition, 2021, ISBN: 9781292422374 (Unit 1,2,5)
Useful Links	
1.	(NPTEL Course) https://onlinecourses.nptel.ac.in/noc22_ee31
2.	(IEEE Control System Society Lecture library) www.ieeecss.org
3.	(Mathworks video series) https://www.mathworks.com/videos/tech-talks/controls.html https://www.mathworks.com/videos/series/understanding-control-systems-123420.html
4.	(Control engineering Journals) www.journals.elsevier.com/control-engineering-practice https://onlinelibrary.wiley.com/journal/5197

Mapping of COs and POs

PO → CO ↓	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PSO 1	PSO 2	PSO 3
CO 1	2	2	1	-	-	-	-	-	-	-	2	2	2	3
CO 2	3	3	3	2	1	-	-	-	-	-	2	2	2	3
CO 3	2	2	3	1	-	-	-	-	-	-	2	2	2	3
CO 4	3	3	2	1	-	-	-	-	-	-	2	2	2	3

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Assessment Pattern (with revised Bloom's Taxonomy)

Knowledge Level	MSE	ISE	ESE
Remember	-	4	05
Understand	4	4	10
Apply	5	4	15
Analyse	6	4	15
Evaluate	5	4	15
Create	-	-	-
TOTAL	**20**	**20**	**60**

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Government College of Engineering, Karad					
Third Year (Sem– VI) B. Tech. Mechanical Engineering					
ME3602: Machine Design– I					
Teaching Scheme			**Examination Scheme**		
Lectures	03 Hrs/week		MSE	20	
Tutorials	01 Hrs/week		ISE	20	
Total Credits	04		ESE	60	
			Duration of ESE	03 Hrs	

Prerequisite Course: Strength of Materials

Course Outcomes (CO): Students will be able to

CO1	Understand concept of design and design procedure of machine elements.
CO2	Apply material selection and failure theories of different machine elements
CO3	Design machine elements subjected to static loading and fluctuating loading
CO4	Analyze selection of transmission elements subjected to static and variable loading

	Course Contents	CO	Hours
Unit 1	**Introduction to Machine Design**: Concept of machine design, basic procedure of design of machine elements, use of standards in design **General Three-Dimensional Stress:** Cartesian stress components, 2D- stress tensor, 3D-stress tensor Plane stress, plane strain, obtaining principal stresses at a point from stress tensor (only theoretical treatment) **Selection of Materials:** Review and selection of various engineering material properties, factors governing selection of engineering materials. BIS designation of steels. (*Self Study*:- Alloying elements in steels, effects, and applications, etc) **Design for Static Loading :** Types of loads, failure, factor of safety- its selection and significance, theories of elastic failure and their applications for combined loading etc. Design of knuckle joint, design of cotter joint.	CO1 CO3	(06)
Unit 2	**Design for Fluctuating Loading:** Introduction to fatigue in metals, mechanism of fatigue failure (crack initiation stage, propagation stage, fracture stage), endurance limit, endurance limit modifying factors. Stress concentration and notch sensitivity, fluctuating stresses, S-N diagram under fatigue load, design for finite and infinite life under reversed stresses, cumulative damage in fatigue failure, Soderberg and Goodman diagrams, Modified Goodman diagram	CO1 CO2	(07)
Unit 3	**Design of Threaded & Welded Joints**: Basic types of screw fastening, terminology of screw threads, bolted joint-simple analysis, eccentrically loaded bolted joints in shear, eccentric load perpendicular to axis of bolt, design of turnbuckle, elastic analysis of bolted joint, bolted joint under fluctuating load Welding symbols, butt and fillet welds, strength of butt welds, parallel and transverse fillet welds, eccentric load in the plane of welds, welded joints subjected to bending moment, welded joint subjected to fluctuating forces	CO2	(07)
Unit 4	**Design of Springs:** Types of springs and their applications, styles of end, design of helical compression spring subjected to static loading (stresses in helical springs, the curvature effect, deflection of helical springs), leaf springs	CO1 CO2	(07)
Unit 5	**Design of Shaft, Keys, and Couplings:** Design of solid and hollow shafts based on strength and rigidity, ASME code for shaft design, types and design of keys, types and applications of couplings, design of muff, rigid coupling, flexible bushed pin type flanged coupling	CO1, CO2, CO3	(06)
Unit 6	**Design calculations for selection of Belt and Chain drives:** **Belt drives:** Types and construction of belts, selection of flat belt and V belt from manufacturer's catalogue, pulleys for flat and V belts, ribbed V belts **Chain Drives:** Chain drives, roller chains, geometrical relationships, polygonal effect, power rating of roller chains, sprocket wheels, design of chain drive	CO1, CO4	(07)

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Note:- Some of the theory part in all units shall be parallely completed in tutorials.			
Tutorials:			
1. Application of Theories of failure			
2. Design for static Loading (Cotter joint/ Knuckle joint)			
3. Design for Fluctuating Loading			
4. Design of Threaded and Welded joint			
5. Design of Power screw			
6. Design of Springs			
7. Design of Shafts, keys			
8. Design of Coupling			
9. Design of Belt and chain drive			

Text Books	
1.	"*Shigley's Mechanical Engineering Design*" by J. Keith Nisbett and Richard. G. Budynas, McGraw Hill, 12th Edition, 2024. (Unit 1 to 6)
2.	"*Design of Machine Elements*" by V. B. Bhandari, McGraw Hill Education (India) Pvt Ltd, New Delhi, 5th Edition, 2021. (Unit 1 to 6)
3.	"*Design of Machine Elements*" by M. F. Spotts and T. E. Shoup, Pearson Education Publication, 8thEdition, 2019. (Unit 1 to 6)
Reference Books	
1.	"*Fundamentals of Machine Component Design*" by Robert C. Juvinall and Kurt. M. Marshek, Wiley Ltd., 6th Edition, 2017. (Unit 1 to 6)
2.	"*Machine Elements in Mechanical Design*" by Robert. Mott, Pearson publication, 6th ed, 2018 (Unit 1 to 6)
3.	"*Machine Design An Integrated Approach*" by Robert. L Norton, Pearson Education Publication, 5th Edition, 2013. (Unit 1 to 6)
4.	"*Schaum's Outlines of Machine Design, In SI Units*" by Alfred Hall, Hollowenko, Laughlin, McGraw Hill Education (India) Pvt.Ltd, New Delhi. (Unit 1 to 6)
5.	"*Machine Design Data book*" by V. B. Bhandari, McGraw Hill Education (India) Pvt Ltd, New Delhi, 2nd Edition, 2019. (Unit 1 to 6)

Mapping of COs and POs

PO → CO ↓	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PSO 1	PSO 2	PSO 3
CO 1	2	2	3	1	-	-	-	-	-	-	1	2	2	2
CO 2	2	2	2	1	-	-	-	-	-	-	1	2	2	2
CO 3	3	3	3	2	-	-	-	-	-	-	2	2	3	3
CO 4	3	3	3	2	-	-	-	-	-	-	2	2	3	3

1: Slight(Low) 2: Moderate(Medium) 3: Substantial(High)

Assessment Pattern (with revised Bloom's Taxonomy)

Knowledge Level	MSE	ISE	ESE
Remember	2	2	6
Understand	4	4	12
Apply	4	4	12
Analyse	4	4	12
Evaluate	4	4	12
Create	2	2	6
TOTAL	20	20	60

Chairman BoS
Mechanical Engineering Dept.
Govt. College of Engg., Karad

GovernmentCollegeofEngineering, Karad				
Third Year (Sem –VI) B. Tech. Mechanical Engineering				
ME3603: Mechatronics				
TeachingScheme			**Examination Scheme**	
Lectures	03 Hrs/week		MSE	20
Tutorials	-		ISE	20
Total Credits	03		ESE	60
			Duration of ESE	02 Hrs 30 Min

Pre-Requisite: Basic Electronics

CourseOutcomes(CO): At theendof course, students are able to

CO1	Understand key elements of Mechatronics system, principles of sensors and actuators and its characteristics
CO2	Apply the concept of signal processing and use of interfacing systems such as ADC, DAC.
CO3	Develop PLC ladder Program for various industrial applications.
CO4	Design Simple Mechatronics and IoT based system.

	CourseContents	**CO**	**Hours**
Unit 1	**Introduction** Introduction to Mechatronics, Mechatronics systems, Measurement systems, Control systems, Multi discipline scenario. **Transducers / Sensors**: Position sensors: limit switch, photo electric switches, proximity sensors, Pneumatic limit valves and backpressure sensors, Pressure switches, Incremental and absolute encoders and relays. Displacement sensors: Potentiometer sensors, LVDT, capacitive sensors, inductive sensors. **Actuators:** AC Motors, DC Motors, BLDC Motors, Stepper Motors, Servo Motors, Solenoid Actuators.	CO1	(07)
Unit 2	**Signalconditioning** Signal conditioning process, Bit Width, Resolution of Measurements in DAQ (Data Acquisition System), Sampling Theorem, Nyquist Criteria. ADC (Analog to Digital Convertor), DAC (Digital to Analog Convertor). Interfacing of Sensors, Actuators with Microcontrollers such as Atmel, Cortex, Arm Processors, ARDUINO, Raspberry PI. Digital and Analog Signal Processing, Time Domain and Frequency domain representation of discrete time signals and systems.	CO2	(07)
Unit 3	**Operational Amplifiers and Driver Circuits** Characteristics of an op-amp, op-amp as voltage follower, inverting amplifier, non-inverting amplifier, summing amplifier, differential amplifier, and comparator. Types of circuits: integrators and differentiators, active filters, current-loop signal transmission, analog switches and multiplexers, and sample and hold. Concepts of the earth ground, magnetic and electrostatic shielding. Stepper Motor, DC Motor, AC Motor Driver Circuits and Shields, its Interfacing with microcontrollers such as ARDUNIO, Raspberry PI.	CO2	(06)
Unit 4	**Programmable Logic Controllers (PLC)** Introduction, Definition, PLC system and components of PLC, input output module, PLC advantages and disadvantages. **Ladder Diagram and PLC Programming Fundamentals:** Basic components and other symbols, Fundamentals of ladder diagram, Machine control terminology, Update–Solve ladder– Update, Physical components vs program components, Internal relays, Disagreement circuit, Majority circuit, Oscillator, Holding circuit, Always ON always OFF contacts, Nesting of ladders. **PLC Functions:** PLC timer functions – Introduction, Timer functions, Industrial applications, Industrial process, Timing applications, PLC control functions– PLC counters and its industrial applications, Introduction to SCADA.	CO4	(08)
Unit 5	**Mechatronics Systems and Its Control Implementation** Traditional Vs Mechatronic Design, Case studies of Mechatronic systems designs, like piece counting system, Pickand place manipulator, Simple assembly task involving a few parts, Part loading / unloading system, Automatic tool and pallet changers etc. Fault finding and troubleshooting, Control Design and Implementation, Control Elements, On-Off, PID controller and its tuning.	CO1 CO4	(04)

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Unit6	**Internet of Things and Industry Internet of Things** IoT fundamentals, Arduino Simulation Environment, Sensor & Actuators with Arduino, Basic Networking with ESP8266 Wi-Fi module, IoT Protocols, Cloud Platforms for IOT, Future trends, home automation, Industry applications, Surveillance applications, Other IoT applications. Design challenges, Development challenges, Security challenges, other challenges.	CO1 CO4	(08)

Text Books	
1.	"*Mechatronics: Electronic Control Systems in Mechanical and Electrical Engineering*", W. Bolton, Pearson Education, 7th Edition, 2018. (Unit 1,2,3,4,5)
2.	"*Mechatronics*", Mahalik, TATA Mc Graw Hill, 5th Edition, 2017. (Unit 1,2,3)
3.	"*Programmable Logical Controller*", James A. Rehg, Pearson Education, 2nd Edition, 2014. (Unit 4)
4.	"*Getting Started with Internet of Things*", Cuno Pfister, O Relly, 2nd Edition 2014 (Unit 6)
References	
1.	"*Mechatronics: Integrated Mechanical Electronic Systems*", K. P. Ramachandran, Wiley, 1st edition, 2008. (Unit 1,2,3)
2.	"*Introduction to Mechatronics*", K. K. Appukuttan, Oxford University Press, 1st ed, 2007. (Unit 1,2,3)
3.	"*Mechatronics: Principles and Applications*", Godfrey C. Onwubolu, Elsevier; 1st ed, 2005. (Unit 1,2,3)
Useful Links	
1.	(NPTEL Course on Mechatronics, IIT Roorkee) https://nptel.ac.in/courses/112103174/
2.	(Industrial Mechatronics systems) www.youtube.com/@realpars
3.	(PLC Programming practice problems with solutions) https://www.sanfoundry.com/100-plc-programming-examples/

Mapping of COs and POs

PO → CO ↓	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PSO 1	PSO 2	PSO 3
CO 1	2	2	1	-	-	-	-	-	-	-	2	2	2	3
CO 2	3	2	3	2	-	-	-	-	-	-	2	2	2	3
CO 3	3	3	3	1	2	-	-	-	-	-	2	2	2	3
CO 4	2	3	2	1	2	-	-	-	-	-	2	2	2	3

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Assessment Pattern (with revised Bloom's Taxonomy)

Knowledge Level	MSE	ISE	ESE
Remember	4	3	05
Understand	4	3	10
Apply	4	3	10
Analyse	4	3	10
Evaluate	4	4	15
Create	-	4	10
TOTAL	**20**	**20**	**60**

Chairman BoS
Mechanical Engineering Dept.
Govt. College of Engg., Karad

Government College of Engineering, Karad				
Third Year (Sem –VI) B. Tech. Mechanical Engineering				
ME3604: Metrology and Quality Control				
Teaching Scheme			**Examination Scheme**	
Lectures	03 Hrs/week		MSE	20
Tutorials	--		ISE	20
Total Credits	03		ESE	60
			Duration of ESE	02 Hrs 30 Min

Prerequisites: Machine Drawing and Manufacturing Engineering

Course Outcomes (CO): Students will be able to

CO1	Demonstrate working principle and construction of measuring instruments and comparators.
CO2	Inspect geometrical parameters according to a drawing.
CO3	Describe quality control and quality assurance concept.
CO4	Apply control charts and sampling plans in an industrial setting.

	Course Contents	CO	Hours
Unit 1	**Introduction** Need of metrology, precision, accuracy, methods and errors in measurement, calibration. **Linear Measurements** International standards of length, line and end measurement, characteristics of measuring instruments, slip gauges. **AngularMeasurement** Bevel protractor, Spirit level, Angle gauges, Sine bar, Sine center, Angle Dekkor, Auto collimator, standard balls and rollers for angle measurement.	**CO1**	**(07)**
Unit 2	**Limits, Fits and Tolerances** Importance of limits system in mass production, IS specifications of limits, unilateral andbilateral tolerances, cost-tolerance relationship, types of fits (including numerical), types ofassembly **Limit Gauges** Importance of limit gauging, types, Taylor's principle, design of plug and ring limit gauges(including numerical). **Comparators** Need for comparator, Principle of operation, its uses in inspection and characteristics of i. Mechanical (dial indicator, sigma comparator) ii. Optical (optical profile projector, Toolmaker's microscope) iii. Electrical comparator iv. Pneumatic comparator **Interferometry** Principle of interferometry and application for checking flatness.	**CO2**	**(09)**
Unit 3	**Geometric parameters** Geometric characteristics of form (straightness, flatness, roundness, cylindricity), orientation (parallelism, perpendicularity, angularity), location (position, concentricity, co-axiality, symmetry) and run-out (circular run-out, total run-out) (ISO- 1101) **CMM Machine** Principle of Coordinate Measuring Machines (CMM), different configurations of CMM, errorinvolved, calibration, probing system, automated inspection system.	**CO2**	**(06)**
Unit 4	**Surface Roughness** Components of surface textures, numerical assessment of surface roughness, surface finish symbols, sampling length, grades of roughness, instruments used in surface roughness assessment (Tomlinson surface meter, Mitutoyo surface roughness tester) **Measurement of Screw Threads** Screw thread terminology, measurement of forms of thread with profile projector, pitch measurement, measurement of thread diameters with standard wire, screw thread micrometer, different errors in screw threads.	**CO3**	**(06)**

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	Gears Measurement of tooth thickness measurement, run out checking, pitch measurement, profile checking, backlash checking, alignment checking, checking of composite errors, errors in gears.		
Unit 5	**Quality Control** Concept of quality, role of quality, Deming's approach, Juran's approach, quality control and quality assurance, specification of quality, factors controlling quality of design and conformance, cost of quality, balance between cost and quality. **Quality Assurance** Seven QC tools, Quality Circles, Kaizen, six sigma, 5S system, Introduction to Business Process Reengineering (BPR).	**CO3**	**(06)**
Unit 6	**Statistical Quality Control** Importance of statistical method in quality control, ND curve, Control charts-Attribute (P, nP, C, U) and variable (X and R chart), their constructions, interpretation and applications. **Acceptance Sampling** Basic concept of sampling inspection, operating characteristic curves (OC curve), conflictinginterests of consumer and producer, producer and consumers risks, single and double sampling plans.	**CO4**	**(06)**

Text Books	
1	"*Engineering Metrology*", I. C. Gupta, Dhanpat Rai Publisher, 8th Edition, 2018. (Unit 1 to 4)
2	"*Engineering Metrology*", R. K. Jain, Khanna Publisher, 22nd Edition, 2022. (Unit 1 to 4)
3	"*Statistical Quality Control*", M. M. Mahajan, Dhanpat Rai & Co. Publisher, 12th ed, 2018. (Unit 5,6)
4	"*Statistical Methods*", S. P. Gupta, Sultan Chand & Sons Publisher, 19th ed, 2022. (Unit 5,6)
Reference Books	
1	"*Metrology*", M. M. Mahajan, Dhanpat Rai & Co. Publisher, 2nd Edition, 2018. (Unit 1 to 4)
2	"*Engineering Metrology and Measurements*", N. V. Raghvendra and L. Krishnamurthy, Oxford publisher, 1st Edition 2013. (Unit 1 to 4)
3	"*Statistical Quality Control*", Douglas C. Montgomery, Wiley Publisher, 8th ed, 2019. (Unit 5,6)
4	"*Statistical Quality Control & Quality Management*", R. C. Gupta, Khanna Publisher, 10th Edition, 1998. (Unit 5,6)
5	"*Statistical Process Control Demystified*", Paul Keller, Mc Graw-Hill Education Publisher, 1st edition, 2011. (Unit 5,6)
Useful links	
1	https://www.youtube.com/watch?v=HpIEeBtJupY&list=PLbMVogVj5nJSZiwuh_tp50dKry8mCxzKA
2	https://www.youtube.com/watch?v=gU7ReUqdne8&list=PLPjSqlTyvDeUHzPu51_QtKBZhcJd6IPVN

Mapping of COs and POs

PO → CO ↓	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PSO 1	PSO 2	PSO 3
CO 1	2	2	2	1	-	-	1	-	-	-	1	2	-	1
CO 2	2	2	2	1	2	-	-	-	1	-	1	2	-	-
CO 3	3	3	3	1	1	1	-	-	-	2	2	2	1	2
CO 4	3	3	3	1	1	1	-	-	-	2	2	2	1	2

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

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Assessment Pattern (with revised Bloom's Taxonomy)

Knowledge Level	MSE	ISE	ESE
Remember	02	02	10
Understand	03	03	15
Apply	05	05	20
Analyse	05	05	10
Evaluate	05	05	05
Create	-	-	-
TOTAL	**20**	**20**	**60**

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Government College of Engineering, Karad					
Third Year (Sem– VI) B. Tech.MechanicalEngineering					
ME3615: Operations Research (Programme Elective-02)					
Teaching Scheme			**Examination Scheme**		
Lectures	03 Hrs/week		MSE	20	
Tutorials	--		ISE	20	
Total Credits	03		ESE	60	
			Duration of ESE	02 Hrs 30 Min	

Prerequisite : Mathematics for mechanical engineering

Course Outcomes (CO): Students will be able to

CO1	Understand quantitative techniques in management decision-making and its applications by using mathematical models
CO2	Analyse LPP, Assignment and Transportation problem
CO3	Evaluate Sequencing and Decisiontheory problem
CO4	Design network by CPM /PERT technique

	Course Contents	CO	Hours
Unit 1	**Introduction** Birth of Operations, Research, Methodology, scope andlimitations, Types of Operations Research, Models, applications in production management, Use of computers in Operations research	**CO1**	**(05)**
Unit 2	**Linear Programming** Formulation of problem, Graphical method, Simplex algorithm for maximization and minimization problems, Sensitivity analysis, Duality theory and its use in economic interpretationand decisionmaking.	**CO1** **CO2**	**(09)**
Unit 3	**Transportation Models:** Structure, Industrial and business applications, Transportation problems and various methods to solve transportation problems, Degeneracy and its solution.	**CO2**	**(06)**
Unit 4	**Assignment Models** Assignment problems, solution of various types of problems, Travelling Salesman problem	**CO3**	**(06)**
Unit 5	**Sequencing** Sequencing of n jobs and 2 and 3 machines, 2 jobs and n machines **Decision Theory** Pay off and regrettables, Decision rules, Decision under certainty and risk, Decision tree.	**CO1** **CO3**	**(06)**
Unit 6	**Project Management** Fundamentals of CPM/ PERT networks, CPM- construction ofnetworks, Critical path, Forward and backward pass, Floats and their significance, PERT-Time estimates, construction of networks, probability of completing projects by given date.	**CO4**	**(08)**
	ISE Assessment pattern will be based on 1. one assignment on each of the unit to be submitted regularly. 2. punctuality, attendance, interaction in class and 3. project based group assignment (maximum five students) to be completed at the end of the course.		

Text Books

1	*"Operations Research"* Panneerselvam R, PHI Learning, 3rd edition 2023. (Unit 1 to 6)
2	*"Operations Research"* Taha H.A, Pearson, Noida, 50th edition 2024.
3	"Operations Research", Hira Gupta,S Chand publication Reprint Edition 2015 (Unit 5,6)
4	*"Operations Research"* .K. Sharma, Mac Millan, 6th edition 2017
5	*"Operations Research–Principles & Practice"* Ravindran, Phillips & Solberg, John Wiley & Sons, Wiley India, 2nd edition 1987
6	*"Introduction to Operations Research-Theory &Applications"*, H.S. Kasana & K.D. Kumar, Springer International Edition, Springer India, 2004.

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Reference Books	
1.	*"Introduction to O.R"*, Hillier & Lieberman (TMH), 2009
2	*"Operations Research"* , R. Panneerselvam (PHI), 2009
3	*"Operations Research"* Natarajan, A.M.; Balasubramani, P. & Tamilrasi, A.Pearson Education, 2005

Useful links	
1	**https://onlinecourses.nptel.ac.in/noc20_ma23**
2	**https://onlinecourses.nptel.ac.in/noc21_me15**

MappingofCOs and POs

PO→ CO↓	PO 1	PO2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PSO 1	PSO 2	PSO 3
CO1	3	2	1	-	-	-	-	-	-	-	2	2	2	3
CO2	3	3	3	1	2	1	-	1	-	1	2	2	2	3
CO3	3	2	3	-	2	-	-	1	-	-	2	2	2	3
CO4	3	3	1	-	3	-	-	-	-	-	2	2	2	3

Assessment Pattern (with revised Bloom's Taxonomy)

Knowledge Level	MSE	ISE	ESE
Remember	4	4	10
Understand	4	4	-
Apply	4	4	10
Analyse	4	4	20
Evaluate	4	4	20
Create	-	-	-
TOTAL	20	20	60

Chairman BoS
Mechanical Engineering Dept.
Govt. College of Engg., Karad

Government College of Engineering, Karad				
Third Year (Sem – VI) B. Tech Mechanical Engineering				
ME3625: Entrepreneurship Development (Programme Elective-02)				
Teaching Scheme			**Examination Scheme**	
Lectures	03 Hrs/week		MSE	20
Tutorials	--		ISE	20
Total Credits	03		ESE	60
			Duration of ESE	02 Hrs 30 Min

Prerequisite : Nil

Course Outcomes (CO): Students will be able to

CO1	Analyze entrepreneurship fundamentals, ecosystem dynamics, and challenges to evaluate opportunities for new ventures in diverse economic contexts.
CO2	Design innovative business ideas using creativity tools and assess their viability through market, technical, and financial feasibility analysis.
CO3	Develop structured business plans and models (e.g., Business Model Canvas) to communicate value propositions
CO4	Apply ethical, legal, and sustainable practices to manage startup operations, funding strategies, marketing efforts, and scaling challenges

	Course Contents	CO	Hours
Unit 1	**Introduction to Entrepreneurship** Definition, stages, characteristics, and importance of entrepreneurship, Types of entrepreneurs, Entrepreneurial mindset and traits (creativity, risk-taking, resilience), Role of entrepreneurship in economic development, Key components of the entrepreneurship, Types of entrepreneurship, Challenges faced by entrepreneurs in developing and developed economies.	**CO1**	**(08)**
Unit 2	**Idea Generation and Opportunity Recognition** Sources of business ideas (market trends, customer needs, technological advancements), Creativity tools, Identifying gaps in the market,Difference between ideas and opportunities, Feasibility analysis (market, technical, financial), SWOT analysis for opportunity evaluation	**CO2**	**(06)**
Unit 3	**Business Planning and Model Development** Business plan, Importance and structure of a business plan, Key components, Pitching a business plan to stakeholders, Introduction to the Business Model Canvas (BMC), Nine building blocks of BMC, Case studies of successful business models.	**CO3**	**(06)**
Unit 4	**Funding and Financial Management** Bootstrapping, angel investors, venture capital, crowdfunding, and government schemes, Equity vs. debt financing, preparing for investor pitches, Basics of financial statements (income statement, balance sheet, cash flow statement), Break-even analysis and budgeting, Managing cash flow and working capital.	**CO1, CO4**	**(07)**
Unit 5	**Marketing and Scaling a Business** Understanding the target market and customer personas, Digital marketing tools (social media, SEO, content marketing), Building a brand and customer loyalty, Challenges of scaling a business, Franchising, partnerships, and global expansion, Leveraging technology for growth.	**CO3, CO4**	**(06)**
Unit 6	**Legal and Ethical Aspects of Entrepreneurship** Business registration and intellectual property rights, Compliance with taxation and labour laws, Contracts and agreements,Ethical decision-making in business, Corporate Social Responsibility (CSR) and sustainable entrepreneurship, Case studies of ethical dilemmas in entrepreneurship.	**CO2, CO4**	**(07)**

ISE Assessment pattern will be based on

1) one assignment on each of the unit to be submitted regularly.
2) punctuality, attendance, interaction in class and
3) project based group assignment (maximum five students) to be completed at the end of the course.

Text Books

1.	*"Entrepreneurship: Successfully Launching New Ventures"*, Bruce R. Barringer and R. Duane Ireland,7th edition, Pearson ,2024
2.	*"Business Model Generation"*, Alexander Osterwalder and Yves Pigneur, John Wiley & Sons, 1st edition, 2010

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3.	*"Venture Deals: Be Smarter Than Your Lawyer and Venture Capitalist"*, Brad Feld and Jason Mendelson, Wiley publication, 4th edition, 2019.
Reference Books	
1.	"*Innovation and Entrepreneurship*",Peter F. Drucker,Harper Business,1st edition,2014.
2.	"*The Lean Startup: How Today's Entrepreneurs Use Continuous Innovation to Create Radically Successful Businesses*", Eric Ries,Crown Publishing Group,1st edition,2011.
3.	"*Business Model Generation: A Handbook for Visionaries, Game Changers, and Challengers*", Alexander Osterwalder& Yves Pigneur,John Wiley & Sons,1st edition,2010
Useful Links	
1.	https://onlinecourses.nptel.ac.in/noc21_mg70/preview https://www.youtube.com/playlist?list=PL8dPuuaLjXtNamNKW5qlS-nKgA0on7Qze https://www.youtube.com/watch?v=fAz9pQ8w9aY https://www.slideshare.net/varshanihanthlade/entrepreneurial-development-44786349

Mapping of COs and POs

PO → CO ↓	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PSO 1	PSO 2	PSO 3
CO 1	1	2	2	3	3	3	3	2	3	3	3	3	2	2
CO 2	1	2	2	2	2	3	3	2	3	3	3	3	2	2
CO 3	1	2	1	3	3	2	2	2	3	3	2	3	2	2
CO 4	1	3	2	2	3	2	3	3	2	2	2	3	1	2

1: Slight(Low) 2: Moderate(Medium) 3: Substantial(High)

Assessment Pattern (with revised Bloom's Taxonomy)

Knowledge Level	MSE	ISE	ESE
Remember	5	5	10
Understand	5	5	15
Apply	5	5	10
Analyse	5	5	20
Evaluate	-	-	5
Create	-	-	-
TOTAL	20	20	60

Chairman BoS
Mechanical Engineering Dept.
Govt. College of Engg., Karad

Government College of Engineering, Karad				
Third Year (Sem– VI) B. Tech. Mechanical Engineering				
ME3635: Additive Manufacturing (Programme Elective-02)				
Teaching Scheme			**Examination Scheme**	
Lectures	03 Hrs/week		MSE	20
Tutorials	--		ISE	20
Total Credits	03		ESE	60
			Duration of ESE	02 Hrs 30 Min

Prerequisite : Manufacturing Engineering

Course Outcomes (CO): Students will be able to

CO1	Understand the concept of additive manufacturing and evaluation of its process sequence
CO2	Discuss the materials required for AM and its molecular structures
CO3	Apply the knowledge of software tools for additive manufacturing
CO4	Develop the 3D component using additive manufacturing process

	Course Contents	CO	Hours
Unit 1	**Introduction to Additive Manufacturing (AM)** General overview Introduction to reverse engineering Traditional manufacturing vis AM Computer aided design (CAD) and manufacturing (CAM) and AM Different AM processes and relevant process physics AM process chain Application level: Direct processes – Rapid Prototyping, Rapid Tooling. Rapid Manufacturing Indirect Processes - Indirect Prototyping. Indirect Tooling, Indirect Manufacturing.	**CO1**	**(03)**
Unit 2	**Software Technologies and Tools** Design/Fabrication Processes: Data Sources, Software Tools, File Formats, Model Repair and Validation, Pre-& Post-processing, Designing for Additive Manufacturing.	**CO1** **CO2**	**(09)**
Unit 3	**Materials science for AM** Discussion on different materials used Use of multiple materials, multifunctional and graded materials in AM Role of solidification rate Evolution of non-equilibrium structure property relationship Grain structure and microstructure.	**CO2**	**(06)**
Unit 4	**AM technologies** Powder-based AM processes involving sintering and melting (selective laser sintering, shaping, and electron beam melting. Involvement). Printing processes (droplet-based 3D Solid-based AM processes - extrusion based fused deposition modelling object Stereolithography Micro- and Nano- additive.	**CO3**	**(06)**
Unit 5	**Process Selection planning, control for AM** Selection of AM technologies using decision methods Additive manufacturing process plan, strategies and post processing. Monitoring and controlof defects, transformation.	**CO1** **CO3**	**(06)**
Unit 6	**Applications of AM** Applications of AM: Aerospace, Automotive, Biomedical Applications of AM. Product Development, Commercialization, Trends and Future Directions in Additive Manufacturing.	**CO4**	**(08)**
	ISE Assessment pattern will be based on 1) one assignment on each of the unit to be submitted regularly. 2) punctuality, attendance, interaction in class and 3) project based group assignment (maximum five students) to be completed at the end of the course.		

Text Books

1	"*Additive Manufacturing Technologies " - Rapid Prototyping to Direct Digital Manufacturing*", Gibson, Rosen, Stucker ", Springer, 2010
2	"*Understanding additive manufacturing: rapid prototyping, rapid tooling, rapid manufacturing*", Andreas Gebhardt, Hanserby, Publishers, 2011.

Reference Books

1.	"*Rapid Manufacturing: An Industrial Revolution for the Digital Age*", Hopkinson, Hague, Dickens, Wiley, 1st edition 2005.
2	"*Advanced Manufacturing Technologies for Medical Applications*"Gibson,Wiley,2005.
3	"*Rapid prototyping: principles and applications*"C.K. Chua, K.F. Leong and C.S. Lim, 3rdEdition, World Scientific, 2010.

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Useful Links	
1	https://additivemanufacturing.com/basics/
2	https://www.ge.com/additive/additive-manufacturing
3	https://www.additive.sandvik/en

MappingofCOs and POs

PO → CO ↓	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PSO 1	PSO 2	PSO 3
CO 1	3	2	2	1	1	1	1					2	1	2
CO 2	2	1		1		1						3	2	1
CO 3	2	2	2	1	1							2	2	3
CO 4	3	3	2	2	2	1	2					3	2	3

Assessment Pattern (with revised Bloom's Taxonomy)

Knowledge Level	MSE	ISE	ESE
Remember	-	-	-
Understand	5	5	20
Apply	10	10	20
Analyse	-	-	-
Evaluate	5	5	20
Create	-	-	-
TOTAL	20	20	60

Chairman BoS
Mechanical Engineering Dept.
Govt. College of Engg., Karad

Government College of Engineering, Karad					
Third Year (Sem –VI) B. Tech. Mechanical Engineering					
ME3645: Product Design and Development(Programme Elective-02)					
Teaching Scheme			**Examination Scheme**		
Lectures	03 Hrs/week		MSE	20	
Tutorials	--		ISE	20	
Total Credits	03		ESE	60	
			Duration of ESE	02 Hrs 30 Min	

Course Outcomes (CO): Students will be able to

CO1	Understand product design phases, approaches, and validation methods.
CO2	Analyse customer needs and perform economic evaluations in product development.
CO3	Create and assess product concepts using design techniques and modelling.
CO4	Apply reverse engineering, benchmarking, and Design for X techniques in product development.

	Course Contents	CO	Hours
Unit 1	**Introduction to Product Design and development** Definition of product design, Essential Factors for product design, Product design phases, Modern approaches to product design, standardization, simplification and specialization in product design product development, product development versus product design, product development team and product development planning, modern product development process with reference to ISO standard, product testing, product validation, Product verification and validation.	**CO1**	**(07)**
Unit 2	**Product Development –Technical and Business Concerns** Mission Statement and Technical Questioning, Technology Forecasting and S Curve, Customer Needs and Satisfaction, Customer Needs - Types and Models, tools for Gathering Customer Needs, Analysis of Gathered Information, Customer Population and Market Segmentation, Economic Analysis of Product (Numerical).	**CO2**	**(06)**
Unit 3	**Product Development from Concept to Product Function** Product information gathering, brainstorming and lateral thinking, morphological analysis of product, generating concepts, concept selection - design evaluation, estimation of technical feasibility, concept selection process, Pugh 's concept, selection charts, concept scoring, process of concept embodiment, system modelling, functional modelling and decomposition, fast method, subtract and operate procedure	**CO3**	**(07)**
Unit 4	**Reverse Engineering** Product Teardown Process, Tear Down Methods, Force Flow Diagrams, Measurement and Experimentation, Applications of Product Teardown, Benchmarking Approach and Detailed Procedure, Tools Used In Benchmarking - Indented Assembly Cost Analysis, Function -Form Diagrams, Trend Analysis, Setting Product Specifications, Introduction to Product Portfolio and Architecture.	**CO4**	**(07)**
Unit 5	**Design for X** Design for manufacturing, Design for assembly, Design for robustness, Design for safety, Design for reliability, Design for environment, Design for piece part production, manufacturing cost analysis. Local, Regional and Global issues, basic life cycleassessment - basic method, weighed sum assessment method and practical problem.	**CO4**	**(07)**
Unit 6	**Product Life Cycle Management and Product Data Management** Introduction, Concept of Product Life Cycle management, Components/Elements of PLM, Customer Involvement, Product Data and Product Workflow, The Link Between Product Data and Product Workflow, Different Phases of Product Life Cycle and corresponding technology. Case study based for design and development of any mechanical product.	**CO4**	**(06)**
	ISE Assessment pattern will be based on 1) one assignment on each of the unit to be submitted regularly. 2) punctuality, attendance, interaction in class and 3) project based group assignment (maximum five students) to be completed at the end of the course.		

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Text Books	
1	"*Product Design and Development*", Karl Ulrich, McGraw Hill,7th Edition, 2020.
2	"*Product Design and Development Handbook: An Innovative, Entrepreneurial, and Structured Approach for Engineering Capstone and Industry Projects*", Steven W. Trimble & Abdelrahman N. Shuaib, Cognella, Inc Publisher, 1st Edition, 2022.
3	*"Product Lifecycle Management (Volume 4): The Case Studies (Decision Engineering)"*, John Stark, Springer Nature Switzerland AG, 1st Edition, 2019.
Reference Books	
1	"*Product Design and Manufacturing*", K. Chitale & R.C. Gupta, PHI Learning Pvt. Ltd., 1st Edition, 2023
2	"*Product Design: Techniques in Reverse Engineering and New Product Development*", Kevin Otto and Kristin Wood, Pearson Education Inc, 1st Edition, 2001.
3	"*Product Lifecycle Management: Driving the Next Generation of Lean Thinking (BUSINESS BOOKS)*",Michael Grieves, McGraw Hill, 2005.
4	"*An Industrial Design Guide Vol. 01: Understanding the science of Product Design*", Neville Songwe Jr & Carmen Andrisani, Creative Design Books, 1st Edition, 2022
Useful links	
1	https://www.youtube.com/watch?v=HN9GtL21rb4&list=PLSGws_74K018yZOnbSaqWJZ837QyBB7vu
2	https://www.youtube.com/watch?v=ooR2HOASuvs&list=PLp6ek2hDcoNALWidcTcFur34atzXNYHjD

Mapping of COs and POs

PO → CO ↓	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PSO 1	PSO 2	PSO 3
CO 1	3	3	3	2	1	2	2	-	-	1	2	2	1	1
CO 2	3	3	3	2	-	2	2	-	-	2	2	2	1	1
CO 3	3	3	3	3	2	2	2	-	-	1	2	2	1	1
CO 4	3	3	3	3	2	2	2	-	-	2	2	2	1	1

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Assessment Pattern (with revised Bloom's Taxonomy)

Knowledge Level	MSE	ISE	ESE
Remember	02	02	05
Understand	03	03	15
Apply	05	05	10
Analyze	05	05	15
Evaluate	05	02	10
Create	-	03	05
TOTAL	**20**	**20**	**60**

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Government College of Engineering, Karad				
Third Year (Sem – VI) B. Tech. Mechanical Engineering				
ME3606: Manufacturing Engineering- (Multi-disciplinary Minor-04)				
Teaching Scheme			**Examination Scheme**	
Lectures	02 Hrs/week		MSE	20
Tutorials	--		ISE	20
Total Credits	02		ESE	60
			Duration of ESE	02 Hrs 30 Min

Prerequisite : Nil

Course Outcomes (CO): Students will be able to

CO1	Understand joining Processes and Techniques
CO2	Discuss fundamentals of lathe machine and metal forming techniques.
CO3	Understand laser cutting operation.
CO4	Operate different manufacturing technologies like injection moulding & CNC.

	Course Contents	CO	Hours
Unit 1	**Joining processes** **Classification of joining processes,** **Welding:-**Terminology and types of joints Arc Welding Processes: Principles and equipment Arc welding, TIG, MIG, Gas Welding Weld inspection, Defects in various joints and their remedies **Soldering:-**Introduction to soldering, Principle of soldering, types of soldering, applications of soldering **Brazing:-** Introduction to brazing ,Principle of brazing, types of brazing, applications of brazing	**CO1**	**(06)**
Unit 2	**Lathe Machine:** Introduction, Working principle, types, specifications, principle parts-Bed, Headstock, Tailstock, Carriage, Lead screw and feed rod, and various lathe operations	**CO2**	**(04)**
Unit 3	**Metal Forming Processes:** **Forging:** Introduction, hot forging, cold forging, open die forging, closed die forging, defects in forging, advantages, disadvantages and application of forging. **Extrusion:** Introduction, Important parameters in extrusion, types of extrusion, defects in extrusion, advantages and disadvantages of extrusion, applications of extrusion.	**CO2**	**(05)**
Unit 4	**Injection moulding:** Introduction to injection moulding, principles, parts of injection moulding process, material, Traditional injection moulding, Micro injection moulding, advantages, limitations, and applications.	**CO4**	**(04)**
Unit 5	**Laser Cutting Processes** Introduction to Non-Conventional Machining and Laser Cutting, Working Principle of Laser Cutting, Types of Lasers Used in Cutting, Components of a Laser Cutting System, Laser Cutting Process Parameters, Materials Processed by Laser Cutting, Advantages and Limitations, Applications in Industries.	**CO3**	**(05)**
Unit 6	**Introduction Advanced Manufacturing** CNC Technology & CNC Tooling: Introduction, Construction and working of CNC and machining centre, Automatic Tool Changer (ATC) and Automatic Tool Setter, Automatic pallet changer (APC),types of controllers, G & M codes.	**CO4**	**(04)**

Tutorials- -- Assignments on each Unit- 6 Nos.

Text Books

1. "*Welding Technology*". O. P. Khanna, Dhanapat Rai Publications,1st edition,2015.
2. "*Manufacturing Technology- Foundry, Forming and Welding, Vol. I*", P. N. Rao, Tata-McGraw-Hill, New Delhi, 3rd edition, 2014.
3. "*Workshop technology Vol.- I, II and III*", Chapman, Edward Arnold Publication Ltd. London, 5th edition,2005
4. "Workshop Technology Vol.- I and II by Hajara Chaudhari", Media Prom and Publication, Mumbai 17th and 16th edition 2021.
5. "*Mechanical Metallurgy*", George E. Dieter, McGraw-Hill Education,3rd Edition,2005
6. "*Understanding Injection Molding Technology*", Douglas M. Bryce, Hanser Publication, 2nd Edition, 2000
7. "*Laser Processing of Engineering Materials: Principles, Procedure and Industrial Application*",John

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	Ion,Butterworth-Heinemann, 1st edition ,2005
8.	"*Laser Fabrication and Machining of Materials*", Narendra B. Dahotre and Sandip P. Harimkar Springer Publication 1st edition 2008
9.	"*Principles of Modern Manufacturing*",Mikell P. Groover , Wiley Publication., 5th Edition.2013
10.	"*Production technology*", R. K. Jain, Khanna Publications volume I, 2012
11	"*Laser Cutting Guide for Manufacturing*", Charles L. Caristan, Society of Manufacturing Engineers, 1st edition, 2004.
Reference Books	
1.	"*Production Technology*", HMT Hand Book- Tata McGraw-Hill of India,1st edition,2006
2.	"*Manufacturing Processes*", R. C. Gupta, New Age International LTD publisher, 2nd edition,2009
2.	"*Manufacturing Processes*", S. E. Rusinoff Times India Press 2nd edition,2015
3.	"*Manufacturing Processes and Materials for Engineers*", Doyle, Prentice Hall of India 3rd edition 2004.
4.	"*Fundamentals of Tool Design*", S. K. Basu, Oxford IBH,6th edition,2010
5.	"*Principles of Laser Materials Processing*", Elijah Kannatey-Asibu, Wiley Publication,2nd print 2023
6.	"*Fundamentals of Tool Design*", Society of manufacturing engineers ,6th edition,2010
7.	"*Lasers: Principles and Applications*", J. Wilson and J.F.B. Hawkes, Prentice Hall Publication, 2nd Edition,2000.
Useful Links	
1.	NPTEL Lecture: https://nptel.ac.in/courses/112103248 https://nptel.ac.in/courses/112105127 https://nptel.ac.in/courses/112107144 https://www.iitg.ac.in/engfac/ganu/public_html/Metal%20forming%20processes_full.pdf https://crescent.education/wp-content/uploads/2019/02/MODULE-I-Injection-Molding-Process.pdf https://rosti.com/wp-content/uploads/2024/01/ROS_Plastic-Injection-Molding.pdf https://www.m-ep.co.jp/assets/document/product/pdf/en/molding.pdf https://www.vssut.ac.in/lecture_notes/lecture1525419667.pdf

Mapping of COs and POs

PO → CO ↓	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PSO 1	PSO 2	PSO 3
CO 1	3	3	2	3	3	1	-	-	2	2	3	3	2	1
CO 2	3	2	1	1	2	-	-	-	2	-	1	2	1	1
CO 3	3	3	2	2	3	2	-	-	2	2	3	3	2	2
CO 4	3	3	3	2	3	3	2	2	2	3	3	3	2	3

1: Slight(Low) 2: Moderate(Medium) 3: Substantial(High)

Assessment Pattern (with revised Bloom's Taxonomy)

Knowledge Level	MSE	ISE	ESE
Remember	4	4	10
Understand	4	4	10
Apply	4	4	10
Analyse	4	4	10
Evaluate	4	4	20
Create	-	-	-
TOTAL	20	20	60

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Govt. College of Engg., Karad

Government College of Engineering, Karad				
Third Year (Sem – VI) B. Tech. Mechanical Engineering				
ME3607: Control Engineering Lab				
Teaching Scheme			**Examination Scheme**	
Practical	02 Hrs/week		ISE	25
Total Credits	01		ESE	25
			TOTAL	50

Course Outcomes (CO)

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

CO1	Understand the response characteristics of various control strategies (ON/OFF, P, I, D, PI, PID)
CO2	Apply transfer function and state space approach for response of SISO and MIMO systems using MATLAB
CO3	Analyze transient response characteristics of LTI systems using MATLAB / Simulink
CO4	Create control solutions for physical applications using appropriate controller.

Course Contents

Experiment 1	Performance of response characteristics of On-Off Controller for Thermal system.	**CO1**
Experiment 2	Performanceon PID controller for Thermal system.	**CO1**
Experiment 3	Performanceon PID controller for DC Motor speed / Fluid Level / Position control	**CO1**
Experiment 4	Demonstration of MATLAB and Simulink interface software (compulsory)	
Experiment 5	MATLAB Programming for Generation of transfer function and block diagram reduction.	**CO1,2**
Experiment 6	MATLAB and Simulink Programming of first order systems	**CO2**
Experiment 7	Using MATLAB, Transient response for responseof linear system to different inputs.	**CO3**
Experiment 8	Designing of PID controller for single DOF of spring-mass-damper system using Simulink	**CO2**
Experiment 9	Simulink for State space modeling of MIMO system.	**CO2,3**
Experiment 10	Modeling of any physical system using Simulation software MATLAB/SIMULINK.	**CO3,4**
Experiment 11	Implementation of ON-OFF / PID control strategy for any physical application	**CO4**
Experiment 12	**Group Activity**	**CO4**

Maximum 3 to 4 students in one group.

Detailedsurvey of collection literature/case studies related to any one of the control system application based on Mechanical system, Electrical/Electronic system, Vibration system, Fluid flow system, Thermal system etc. Survey/case studies includes following points-

1. Introduction/Relevance
2. Objectives
3. Physical layout
4. Block diagram representation
5. Selection of Controller and feedback element
6. Theory/Description and specifications of System Components
7. Principle of working operation
8. Design calculations/theoretical analysis
9. Concluding remarks/comments

Term work should consist of any 10 experiments from the above.

Text Books

1.	"*Control Systems Engineering using MATLAB*", S. N. Sivanandam, S. N. Deepa, Vikas Publishing House Pvt. Ltd., 2nd Edition, 2018.
2.	"*MATLAB and Simulink-Introduction to Applications*", Parth S. Mallick, Scitech Publications (I) Pvt. Ltd, 3nd Edition, 2021
3.	"*Analysis and Design of Control Systems using MATLAB*", Rao V. Dukkipati, New Age International Publishers, 2nd Edition, 2017
4.	"*Automatic Control Engineering*", Francis. H. Raven, Tata McGraw Hill Publication, 5th Edition, ISBN: 0070855943

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Reference Books	
1.	"*Getting Started with MATLAB*", Rudrapratap, Version 6, Oxford University Press, 2nd Edition, 2015
2.	"*Introduction to MATLAB 6*", D. M. Ether, D. C. Kuncicky, D. Hull. Pearson Education, 1st Edition, 2019
3.	"*Getting Started with Control System Toolbox*", Version 5, The Math Works, 2022
Useful Links	
1.	http://www.controlandinstrumentation.com/
2.	https://instrumentationandcontrol.net/
3.	https://www.mathworks.com/videos/tech-talks/controls.html https://www.mathworks.com/videos/series/understanding-control-systems-123420.html

Mapping of COs and POs

PO → CO ↓	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PSO 1	PSO 2	PSO 3
CO 1	2	1	1	-	1	-	-	2	-	-	2	2	2	3
CO 2	3	3	2	2	2	-	-	1	-	-	2	2	2	3
CO 3	2	2	3	2	3	-	-	1	-	-	2	2	2	3
CO 4	3	3	3	1	2	-	-	2	2	1	2	3	3	3

1: Slight(Low) 2: Moderate(Medium) 3: Substantial(High)

Assessment Pattern

Skill Level (as per CAS Sheet)	Exp 1	Exp 2	Exp 3	Exp 4	Exp 5	Exp 6	Exp 7	Exp 8	Exp 9	Exp10	Avg
Task I	15	15	15	15	15	15	15	15	15	15	**15**
Task II	05	05	05	05	05	05	05	05	05	05	**05**
Task III	05	05	05	05	05	05	05	05	05	05	**05**
ISE											**25**

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Govt. College of Engg., Karad

Government College of Engineering, Karad				
Third Year (Sem – VI) B. Tech. Mechanical Engineering				
ME3608: Mechatronics Lab				
Teaching Scheme			**Examination Scheme**	
Practical	02 Hrs/week		ISE	25
Tutorial	-		ESE	25
Total Credits	01		TOTAL	50

Course Outcomes (CO)

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

CO1	Understand interfacing of sensors, actuators with Arduino and Programmable Logic controllers.
CO2	Apply suitable signal conditioning devices for interfacing of sensors and actuators
CO3	Develop and create a PLC programming and implement on practical system
CO4	Create mechatronic system for measurement and control applications

Course Contents

Experiment 1	Sensor Interfacing with Microcontroller Arduino: IR, Ultrasonic Distance	**CO1**
Experiment 2	Sensor Interfacing with Microcontroller Arduino: Strain Gauge, Thermocouple	**CO1**
Experiment 3	Actuator Interfacing with Microcontroller Arduino: DC Motor, Stepper Motor	**CO2**
Experiment 4	Actuator Interfacing with Microcontroller Arduino: Solenoid Actuator, Heater	**CO2**
Experiment 5	Interfacing of sensors and actuators with PLC	**CO3**
Experiment 6	PLC sourcing and sinking connection and interfacing of PNP and NPN solid state sensors	**CO2**
Experiment 7	PLC Ladder programming for simple industrial sequence using trainer	**CO2,3**
Experiment 8	Development of IoT system using ESP8266 Module	**CO3,4**
Experiment 9	Interfacing of Sensors and Data Acquisition using dSPACE DS1104 Microcontroller.	**CO4**
Experiment 10	**Group Activity** (Mandatory) : Development of simple mechatronics system for Home/Lab automation	**CO4**

Maximum 3 to 4 students in one group.

1. Introduction/Relevance
2. Objectives
3. Physical layout
4. Block diagram representation
5. Selection of sensors and controllers
6. Theory/Description and specifications of System Components
7. Principle of working operation
8. Program (Arduino IDE / Ladder)
9. Concluding remarks/comments

Term work should consist of any 08 experiments of the above.

Text Books

1.	"*Microprocessor Architecture Applications*",Ramesh S. Gaonkar, New Age International Publishers Ltd., 2016
2.	"*Mechatronics and Control systems*",W.Bolton,PearsonEducation, 4th Edition,2019
3.	""*Mechatronics*"", Mahalik, TATA Mc Graw Hill, 5th Edition, 2014
4.	"*ProgrammableLogicalController*",Hackworth,PearsonEducation, 4th Edition, 2020.
5.	"*Getting Started with Internet of Things*", Cuno Pfister, O Relly 2021

Reference Books

1.	K.P.Ramachandran,"*Mechatronics: Integrated Mechanical Electronic Systems*", Wiley,2008
2.	K. K. Appukuttan, "*Introduction to Mechatronics*", Oxford University Press,2007
3.	GodfreyC.Onwubolu,"*Mechatronics: Principles and Applications*", Elsevier; First edition 2006

Useful Links

1.	https://www.sanfoundry.com/100-plc-programming-examples/
2.	https://youtube.com/playlist?list=PLGs0VKk2DiYw-L-RibttcvK-WBZm8WLEP&feature=shared

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Mapping of COs and POs

PO → CO ↓	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PSO 1	PSO 2	PSO 3
CO 1	3	1	1	-	1	-	-	2	-	-	2	2	2	3
CO 2	3	3	2	2	2	-	-	1	-	-	2	2	2	3
CO 3	3	2	3	2	3	-	-	1	-	-	2	2	2	3
CO 4	3	3	3	1	2	-	-	2	2	1	2	3	3	3

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Assessment Pattern

Skill Level (as per CAS Sheet)	Exp 1	Exp 2	Exp 3	Exp 4	Exp 5	Exp 6	Exp 7	Exp 8	Avg
Task I	15	15	15	15	15	15	15	15	**15**
Task II	05	05	05	05	05	05	05	05	**05**
Task III	05	05	05	05	05	05	05	05	**05**
ISE									**25**

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Government College of Engineering, Karad				
Third Year (Sem – VI) B. Tech. Mechanical Engineering				
ME3609: Metrology and Quality Control Lab				
Laboratory Scheme:			**Examination Scheme:**	
Practical	2 Hrs/Week		ISE	25
Total Credits	1		ESE	25

Course Outcomes (CO): Students will be able to

CO1	Select and use an appropriate linear, angular measuring instrument and comparator for inspection.
CO2	Perform an inspection on CMM for dimensional and geometrical features.
CO3	Measure surface roughness, flatness, screw thread parameter and gear tooth parameter using appropriate instrument.
CO4	Plot normal distribution curve and control charts for a given manufacturing process.

Course Contents		CO
Experiment 1	Perform linear measurement using various linear measuring instruments.	CO1
Experiment 2	Perform angular measurement using various angle measuring instruments viz Bevel protractor, Sine Bar, Auto-collimator.	CO1
Experiment 3	Verification of dimensions of given components using Mechanical and pneumatic comparator.	CO1
Experiment 4	Use of optical profile projector and tool makers microscope for Screw thread measurement.	CO3
Experiment 5	Flatness measurement of a surface with the help of an optical flat.	CO3
Experiment 6	Use of CNC-CMM and inspection fixtures to inspect dimensions and geometrical parameters of a given drawing.	CO2
Experiment 7	Measurement of surface roughness with surface tester and measurement of gear tooth thickness with gear tooth Vernier Calliper.	CO3
Experiment 8	Screw thread measurement (major, minor and effective diameter) with the help of floating carriage Micrometer.	CO3
Experiment 9	Production Job Inspection and Quality Assessment Using Statistical Process Control (SPC) Techniques.	CO4
Experiment 10	Industrial Visit for studying different comparators, various measuring instruments.	CO1-CO4
Experiment 11	Group Activity (Compulsory) A group of 5 students can select any one group activity given below: Students should collect drawing of a component from industry and suggest a measuring instrument / method to measure various dimension and geometric parameters in it.	CO1-CO4

List of Submission: Minimum number of Experiments: 10.

Text Books

1.	"Engineering Metrology", I. C. Gupta, Dhanpat Rai Publisher, 8th Edition, 2018
2.	"Engineering Metrology", R. K. Jain, Khanna Publisher, 21st Edition, 2015
3.	" Statistical Quality Control", M. Mahajan, Dhanpat Rai & Co. Publisher, 12th Edition, 2018
4.	"Statistical Methods", S. P. Gupta, Sultan Chand & Sons Publisher, 46th Edition, 2019

Reference Books

1	"Metrology", M. Mahajan, Dhanpat Rai & Co. Publisher, 2nd Edition, 2018
2	"Practical Engineering Metrology", Sharp K.W.B., Pitman, London, 1966
3	"Statistical Quality Control", Douglas C. Montgomery, Wiley Publisher, 7th Edition,2012
4	"Statistical Quality Control & Quality Management", R. C. Gupta, Khanna Publisher, 10th Edition,1998.

Useful links

1	https://www.youtube.com/watch?v=HpIEeBtJupY&list=PLbMVogVj5nJSZiwuh_tp50dKry8mCxzKA
2	https://www.youtube.com/watch?v=gU7ReUqdne8&list=PLPjSqITyvDeUHzPu51_QtKBZhcJd6IPVN

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Mapping of COs and POs:

PO → CO ↓	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PSO 1	PSO 2	PSO 3
CO 1	3	3	2	1	-	-	-	-	-	-	-	3	-	1
CO 2	3	3	2	1	3	-	-	-	2	-	1	3	1	1
CO 3	3	3	2	1	2	-	-	-	1	-	-	3	-	-
CO 4	3	3	3	1	1	-	-	-	1	2	2	2	1	2

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Assessment Pattern:

Skill Level (as per CAS Sheet)	Exp 1	Exp 2	Exp 3	Exp 4	Exp 5	Exp 6	Exp 7	Exp 8	Exp 9	Exp10	Avg
Task I	15	15	15	15	15	15	15	15	15	15	**15**
Task II	05	05	05	05	05	05	05	05	05	05	**05**
Task III	05	05	05	05	05	05	05	05	05	05	**05**
ISE											**25**

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Government College of Engineering, Karad				
Third Year (Sem – VI) B. Tech. Mechanical Engineering				
ME3610 : Minor Project				
Laboratory Scheme:			**Examination Scheme:**	
Practical	02 Hrs/week		ISE	50
Total Credits	01		ESE	--

Course Outcomes (CO): Students will be able to

CO1	Understand team work to realize an engineering task.
CO2	Analyse the steps involved for the selection, execution and reporting of the project.
CO3	Apply engineering knowledge to real life problem solving.
CO4	Evaluate community needs and convert idea in to product.

Course Contents

The main aim of this course is to demonstrate the important attributes like critical thinking, creativity, collaborative efforts and communication skills in students. The aim is also to make students aware with the process involved in making product from idea. Not more than five students may carry out the minor project together. One supervisor from the department shall be assigned maximum two project batches of the minor project.

The steps involved for completion of minor project includes, but not limited to:

1	Conceptualization of innovative idea through literature and market survey; sight visits; interaction with community or industry, socio-economic survey, etc.
2	Design of product, processes, methods and systems using multidisciplinary knowledge.
3	Fabrication of product, development of software, measurement methods, etc.
4	Deployment, implementation and demonstration of minor project.
5	Presentation of minor project.

Guidelines for Minor Project Selection:

1. Project work shall be based on any of the following :

- Design of any equipment /test setup/product
- Design and manufacturing of drilling jig for a component
- Design and manufacturing of milling fixture for component
- Design and manufacturing of press tool for component and trials for the same. (1.5 mm M.S. sheet)
- Prototype modelling for 3-4 parts assembly. (Design CAD model for a component / assembly and make it with the help of 3-D printer)
- Design a model and preparing the cam programming and making of the part with the help of VMC.
- Making the model of any thermal engineering system
- Any electromechanical /hydraulic/pneumatic circuit design with PLC for particular application
- Design and manufacturing pneumatic pick and place unit
- Design a pattern and make it with 3D printer and pour a casting with the help of AUTO CAST
- Auto pouring ladle for aluminium foundry
- Semi-automatic gravity die casting machine
- Analysis for auto component with the help of ANSYS software
- Energy audit for an industry/hospital/institute (up to 10 kW) 2. Hardware/numerical or theoretical
- Design and fabrication of any abstract idea.

2. Hardware/numerical or theoretical analysis/review of survey study/research and development work
   - The subject content of the minor project shall be from emerging/thrust areas, topic of current relevance
   - The completion of work, the submission of the report and assessment should be done at the end of semester.

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	Project Report Format: Project report should be of 15 to 20 pages (typed on A4 size sheets). For standardization of the project reports the following format should be strictly followed. 1. Page Size: Trimmed A4 2. Top Margin: 1.00 Inch 3. Bottom Margin: 1.32 Inches 4. Left Margin: 1.5 Inches 5. Right Margin: 1.0 Inch 6. Para Text: Times New Roman 12 Point Font 7. Line Spacing: 1.5 Lines 8. Page Numbers: Right Aligned at Footer, Font 12 Point, Times New Roman 9. Headings: Times New Roman, 14 Point Bold Face 10. Certificate: All students should attach standard format of Certificate as described by the department. Certificate should be awarded to batch and not to individual student. Certificate should have signatures of Guide, Head of Department and Principal/ Director. 11. Index of Report: a. Title Sheet b. Certificate c. Acknowledgement d. Table of Contents e. List of Figures f. List of Tables 12. References: References should have the following format For Books: "Title of Book", Authors, Publisher, Edition For Papers: "Title of Paper", Authors, Journal/Conference Details, Year
	List of Submission 1. Working model of the project 2. Project Report 3. Presentation and demonstration of project in exhibition

Mapping of COs and POs

PO → CO ↓	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PSO 1	PSO 2	PSO 3
CO 1	2	-	-	-	-	-	-	3	2	1	2	-	2	2
CO 2	2	3	3	2	2	1	1	2	1	1	2	2	2	2
CO 3	2	2	3	1	2	-	-	1	-	1	2	2	2	2
CO 4	1	1	2	1	2	1	-	-	3	3	2	2	2	2

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

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EXIT COURSE SYLLABI

ONLY APPLICABLE

FOR STUDENTS OPTING FOR EXIT AFTER

THIRD YEAR B.TECH MECHANICAL ENGINEERING

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Mechanical Engineering Dept.
Govt. College of Engg., Karad

Government College of Engineering, Karad				
Third Year (Exit Course) B. Tech. Mechanical Engineering				
ME-EC-0301- Industrial Training / Internship				
Teaching Scheme:			**Examination Scheme:**	
Practical	-		ISE	-
Total Credits	04		ESE	-

Prerequisite : Third Year Mechanical Engineering

Course Outcomes (CO): Students will be able to

CO1	To make the students aware or familiar with the industrial work & Accustomed with industrial environment
CO2	Learn and apply appropriate techniques, resources and modern engineering tools.
CO3	Understand functions of maintenance, purchase, R & D, materials management, Scheduling & dispatch, TQM and housekeeping.
CO4	Create, select, learn and apply appropriate techniques, resources, and modern engineering tools

Course Contents	CO	Hours
The students have to undergo an industrial training of four weeks in an industry preferably dealing with mechanical engineering and allied discipline after completion of first year during the summer vacation. He / she will work under supervision of institute guide and industrial guide. The students have to submit a report of the training undergone and make presentation before evaluation committee constituted by the department. An internal evaluation will be conducted for examining the quality and authenticity of contents of the report and award the marks. Report is based on compilation of work carried out related to machineries, measuring instruments, state-of-art technologies, plant layout, Industry organization chart, Management functions, Safety, rules and regulations, documentation work, Industry standards, processes and tools used, fixtures and gauges used, Industrial automation, Computerization and software used in various departments, product flow, testing and quality control checks, painting and packing procedures, housekeeping practices as identified etc. Quantum and quality of work will be monitored by industrial and academic guide both. Industrial Training Report Format: Maximum five students in one batch, shall work under one Faculty. However, each student should have different industrial training and its presentation. The report should be of 20 to 40 pages. For standardization of the report the following format should be strictly followed. 1. Page Size: Trimmed A4 2. Top Margin: 1.00 Inch 3. Bottom Margin: 1.32 Inches 4. Left Margin: 1.5 Inches	**CO1,CO2, CO3, CO4**	**4Week**

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	5. Right Margin: 1.0 Inch 6. Para Text: Times New Roman 12 Point. Font 7. Line Spacing: 1.5 Lines 8. Page Numbers: Right Aligned at Footer. Font 12 Point. Times New Roman 9. Headings: Times New Roman, 14 Point., Bold Face 10. Certificate:All students should attach standard format of Certificate as described by the department. Certificate should be awarded to batch and not to individual student. Certificate should have signatures of Guide, Head of Department and Principal. 11. The entire report should be documented as one chapter with details like a. "Name of Industry with address along with completed training certificate" b. Area in which Industrial training is completed All Students have to present their reports individually Upon successful completion of this course, the student should be able to answer following questions, 1. Which subjects you found useful for this training? 2. Have you seen any chart, tables, and graphs in industry? What was its meaning for you? 3. Can you design any system or part of it from this training? If not what knowledge you feel inadequate? 4. Was this training involved knowledge of electrical, electronics, civil, chemical or any process engineering industry? 5. Have you come across any technical difficulty in training? If yes write in short, How you solved? 6. What was timing for training? Have you followed it? Were people in industry sincere in their work? 7. Which language used for communication in industry you visited? Have you talked there? 8. What pollution measures were taken by the industry for their waste disposal? 9. What is most important part of training you remember? 10. What is current issue in technical field you find most challenging? 11. Do you think this training is useful? What is its use? 12. Is there any scope for research you find while undergoing this training? Execution scheme:-work load of the assessment can be assigned to the project or seminar guide.		
List of Submission:			
1.	Report based on training done as per the given format.		

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GovernmentCollegeofEngineering,Karad				
Third Year (Exit Course) B.Tech. Mechanical Engineering				
ME-EC-0302: Computer Aided Engineering Lab				
LaboratoryScheme:			**Examination Scheme:**	
Practical	8 Hrs/Week		ISE	100
Total Credits	4		ESE	----

Prerequisites: ThirdYearMechanicalEngineering

CourseOutcomes(CO): studentswillbeableto-

CO1	Develop Model and Simulate 1D/2D/3D static and dynamic structural problems
CO2	Analyze Thermal and ThermoMechanical problems: Heat Transfer and Thermal Stress Analysis
CO3	Apply FEA for Multi-disciplinary problems and Multi-body dynamic problems
CO4	Develop Matlab program fro geometric transformations and analysis

Course Contents		CO
Experiment1	FEA Modeling and Simulations of 1D/2D/3D practical problem: Fatigue Life Analysis	CO1
Experiment2	FEA Modeling and Simulations of 1D/2D/3D practical problem: Modal Analysis	CO1
Experiment3	FEA Modeling and Simulations of 1D/2D/3D practical problem: Static Structural Analysis	CO1
Experiment4	FEA Modeling and Simulations of 1D/2D/3D practical problem: Thermal Analysis	CO2, CO3
Experiment5	FEA Modeling and Simulations of 1D/2D/3D practical problem: Multi-Body Dynamic Analysis, Crash Analysis etc.	CO2 CO3
Experiment6	Flow over an aerodynamic foil external flow using ANSYS fluent	CO2, CO3
Experiment7	Simulation of electronic cooling equipment using ANSYS fluent	CO2, CO3
Experiment8	Simulation of a rotating body (moving part) using ANSYS fluent	CO2, CO3
Experiment9	MATLAB code on 2D Transformation on translation, scaling and reflection	CO4
Experiment10	MATLAB code on 3D Transformation on translation, scaling and reflection	CO4
Experiment11	MATLAB code on Temperature distribution in fin	CO4
Experiment12	Finite Element Formulation for 1D problem and solve it by using MATLAB to solve stepped bar/composite bar and verify with hand calculations	CO4

ListofSubmission: MinimumnumberofExperiments: Any 10 of the above

TextBooks

1. MATLAB Guide to Finite Elements - Peter I. Kattan – Springer, Third Edition, 2003
2. Xiaolin Chen, Yijun Liu, Finite Element Modeling and Simulation with ANSYS Workbench, CRC Press, 2014
3. Saeed Moaveni, Finite Element Analysis, Theory and Application with ANSYS, Pearson Publication, 2011

MappingofCOsand POs:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	2	3	3	2	3	1	1	1	1	-	1	2	3	-
CO2	2	3	3	2	3	1	1	1	1	-	1	2	3	-
CO3	2	3	3	2	3	1	1	1	1	-	1	2	3	-
CO4	2	3	3	2	3	1	1	1	1	-	1	2	3	-

1:Slight(Low) 2:Moderate (Medium) 3:Substantial(High)

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AssessmentPattern:

SkillLevel(asper CAS Sheet)	Exp1	Exp2	Exp3	Exp4	Exp5	Exp6	Exp7	Exp8	Exp9	Exp 10	Avg
TaskI	50	50	50	50	50	50	50	50	50	50	50
TaskII	25	25	25	25	25	25	25	25	25	25	25
TaskIII	25	25	25	25	25	25	25	25	25	25	25
ISE											100

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Government College of Engineering, Karad					
Third Year (Exit Course) B. Tech. Mechanical Engineering					
ME-EC-0303: Workshop (Non-conventional Machining) (Exit Course)					
Laboratory Scheme:			**Examination Scheme:**		
Practical	08 Hrs/week		ISE	100	
Total Credits	04		ESE	-	

Prerequisites: ThirdYearMechanicalEngineering

Course Outcomes(CO): At theend ofthiscourse,studentwillbeable to:

CO1	Create component on EDM machine.
CO2	Prepare a component on 3D printer using CAD model
CO3	Create components on injection molding & ultrasonic label cutting machine
CO4	Operate water /abrasive water jet machine& laser cutting

ListofExperiments		CO
Experiment 1	Create component on plastic injection moulding machine.	CO3
Experiment 2	Manufacture component on Wire cut EDM machine	CO1
Experiment 3	To investigate the effect of metal removal rate (MRR), surface roughness on work piece on Wire cut EDM machine.	CO1
Experiment 4	To prepare a scanned model of 3D object using 3D scanner. Use of scanner for reverse engineering.	CO2
Experiment 5	To prepare component from 3D printer by using CAD model.	CO2
Experiment 6	Use of Ultrasonic label cutting machine	CO3
Experiment 7	Use of Laser cutting machine.	CO4
Experiment 8	Industrial Visit for Water or Abrasive jet machining.	CO4

TextBooks

1	P. K. Mishra "Nonconventional Machining", Narosa Publishing House, New Delhi, 2014
2	P. C. Pandey and H. S. Shan "Modern Machining Processes", Tata McGraw Hill Publishing Company PvtLtd.,New Delhi,2008
3	Gibson, Rosen, Stucker "Additive Manufacturing Technologies" - Rapid Prototyping to Direct Digital Manufacturing , Springer, 2010

ReferenceBooks

1	Ronald. A. Kohser "Material and Processes in Manufacturing", Prentice Hall of India Pvt. Ltd., New Delhi,2007
2	G. F. Benedict, Marcel Dekker Inc "Non-traditional Manufacturing Processes", New York 2017
3	C.K. Chua, K.F. Leong and C.S. Lim, Rapid prototyping: principles and applications, 3rd Edition, World Scientific, 2010.

MappingofCOs and POs

PO→ LO↓	PO 1	PO2	PO3	PO 4	PO 5	PO 6	PO7	PO 8	PO9	PO 10	PO 11	PSO 1	PSO 2	PSO 3
CO 1	3	1	2	1	3						3	3	1	1
CO2	3	2	2	2	3	2		1		2	3	3	2	2
CO3	3	1	2	2	3			2			3	3	1	1
CO4	2	2	2	1	3						3	3	2	1

1:Slight(Low) 2:Moderate (Medium) 3:Substantial(High)

AssessmentPattern

SkillLevel(asper CAS Sheet)	Exp1	Exp2	Exp3	Exp4	Exp5	Exp6	Exp7	Exp8	Avg
TaskI	50	50	50	50	50	50	50	50	50
TaskII	25	25	25	25	25	25	25	25	25
TaskIII	25	25	25	25	25	25	25	25	25
ISE									100

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