B. Tech. Program (Mechanical Engineering)

Shri Vile Parle Kelavani Mandal's

Dwarkadas J. Sanghvi College of Engineering

(Autonomous College affiliated to the University of Mumbai)

Scheme and detailed syllabus (DJS23)

Third Year B. Tech

In

Mechanical Engineering

(Semester V)

Shri Vile Parle Kelavani Mandal's
DWARKADAS J. SANGHVI COLLEGE OF ENGINEERING
(Autonomous College Affiliated to the University of Mumbai)
NAAC Accredited with "A" Grade (CGPA : 3.18)

Scheme for Third Year of B.Tech. Program in Mechanical Engineering: Semester V (Autonomous-DJS23 NEP)
(Academic Year 2025-2026)

Sr. No.	Course Code	Courses	Teaching Scheme (hrs.)				Continuous Assessment (A) (marks)			Semester End Assessment (B) (Marks)					(A+B)	Total Credits	
			Th	P	T	Credits	Th	T/W	Total CA (A)	Th / Cb	O	P	O & P	Total SEA (B)			
1	DJS23MCPC501	Theory of Machines	3	--	--	3	40	--	40	60	--	--	--	60	100	3	4
	DJS23MLPC501	Theory of Machines Laboratory	--	2	--	1	--	25	25	--	--	--	--	--	25	1	
2	DJS23MCPC502	Mechanical Measurements and Metrology	3	--	--	3	40	--	40	60	--	--	--	60	100	3	4
	DJS23MLPC502	Mechanical Measurements and Metrology Laboratory	--	2	--	1	--	25	25	--	--	--	--	--	25	1	
3	DJS23MCPC503	Fluid Mechanics and Machinery	3	--	--	3	40	--	40	60	--	--	--	60	100	3	4
	DJS23MLPC503	Fluid Mechanics and Machinery Laboratory	--	2	--	1	--	25	25	--	25	--	--	25	50	1	
4	DJS23MCMD501	Industrial Electronics	2	--	--	2	40	--	40	60	--	--	--	60	100	2	3
	DJS23MLMD501	Industrial Electronics Laboratory	--	2	--	1	--	25	25	--	--	--	--	--	25	1	
5	DJS23MLMD502	Database Management System Laboratory	--	2	--	1	--	25	25	--	--	--	25	25	50	1	1
6 @	DJS23MCPE511	Reliability Engineering	3	--	--	3	40	--	40	60	--	--	--	60	100	3	4
	DJS23MLPE511	Reliability Engineering Laboratory	--	2	--	1	--	25	25	--	--	--	--	--	25	1	
	DJS23MCPE512	Renewable Energy Systems	3	--	--	3	40	--	40	60	--	--	--	60	100	3	4
	DJS23MLPE512	Renewable Energy Systems Laboratory	--	2	--	1	--	25	25	--	--	--	--	--	25	1	
	DJS23MCPE513	Advance Materials and Processes	3	--	--	3	40	--	40	60	--	--	--	60	100	3	4
	DJS23MLPE513	Advance Materials and Processes Laboratory	--	2	--	1	--	25	25	--	--	--	--	--	25	1	
	DJS23MCPE514	Automotive Prime Movers	3	--	--	3	40	--	40	60	--	--	--	60	100	3	4
	DJS23MLPE514	Automotive Prime Movers Laboratory	--	2	--	1	--	25	25	--	--	--	--	--	25	1	
	DJS23MCPE515	Adhesive Technology	3	--	--	3	40	--	40	60	--	--	--	60	100	3	4
	DJS23MLPE515	Adhesive Technology Laboratory	--	2	--	1	--	25	25	--	--	--	--	--	25	1	
	DJS23MCPE516	Data Analytics	3	--	--	3	40	--	40	60	--	--	--	60	100	3	4
	DJS23MLPE516	Data Analytics Laboratory	--	2	--	1	--	25	25	--	--	--	--	--	25	1	
	DJS23MCPE517	Fundamentals of Business Development	3	--	--	3	40	--	40	60	--	--	--	60	100	3	4
	DJS23MLPE517	Fundamentals of Business Development Laboratory	--	2	--	1	--	25	25	--	--	--	--	--	25	1	
7	DJS23ITHSX10	Environmental Studies	--	--	1	1	--	25	25	--	--	--	--	--	25	1	1
8	DJS23IPSCX03	Innovative Product Development III	--	2	--	1	--	25	25	--	--	--	25	25	50	1	1
		Total	**14**	**14**	**1**	**22**	**200**	**200**	**400**	**300**	**25**	**0**	**50**	**375**	**775**	**22**	

@Any 1 Department Elective from the given list.

Prepared by Checked by Head of the Department Principal

Continuous Assessment (A):

Course	Assessment Tools	Marks	Time (min.)
Theory	a. Term test 1 (based on 40 % syllabus)	15	45
	b. Term test 2 (next 40 % syllabus)	15	45
	c. Assignment / course project / group discussion / presentation / quiz/ any other.	10	--
	Total Marks (a + b + c)	40	--
Audit course	Performance in the assignments / quiz / power point presentation / poster presentation / group project / any other tool.	--	As applicable
Laboratory	Performance in the laboratory and documentation.	25	
Tutorial	Performance in each tutorial & / assignment.	25	
Laboratory &Tutorial	Performance in the laboratory and tutorial.	50	

The final certification and acceptance of term work will be subject to satisfactory performance upon fulfilling minimum passing criteria in the term work / completion of audit course.

Semester End Assessment (B):

Course	Assessment Tools	Marks	Time (hrs.)
Theory / * Computer based	Written paper based on the entire syllabus.	60	2
	* Computer-based assessment on the college premises.		
Oral	Questions based on the entire syllabus.	25	As applicable
Practical	Performance of the practical assigned during the examination and the output / results obtained.	25	2
Oral & Practical	Project based courses - Performance of the practical assigned during the examination and the output / results obtained. Based on the practical performed during the examination and on the entire syllabus.	as per the scheme	2

Prepared by Checked by Head of the Department Principal

Program: Mechanical Engineering	T.Y. B.Tech	Semester: V
Course: Theory of Machines (DJS23MCPC501)		
Course: Theory of Machines Laboratory (DJS23MLPC501)		

Pre-requisites:

1. Computational engineering mechanics.

Objectives:

1. To understand the basics of kinematics, including different types of mechanisms, and the velocity and acceleration analysis methods.
2. To learn the principles of power transmission using chains, gears, and gear trains.
3. To understand the basics of vibration and analyse systems subjected to free undamped vibrations.
4. To study different types of damping and the behaviour of damped vibration systems.
5. To study forced vibrations, vibration isolation, and the use of measuring instruments for vibration analysis.

Outcomes: On completion of the course, the learner will be able to:

1. Determine the velocity and acceleration of mechanism links.
2. Determine basic design parameters of power transmission elements like chains and gears.
3. Analyse the vibration response of systems subjected to free undamped vibrations.
4. Analyse the vibration response of systems subjected to free damped vibrations.
5. Analyse the vibration response of systems subjected to forced vibrations.

Theory of Machines (DJS23MCPC501)		
Unit	**Description**	**Duration**
1	**1.1 Basic Kinematics:** Kinematic link and types, Kinematic pairs and types, Types of constrained motions, Kinematic chains, Types of joints, Degree of freedom (mobility), Kutzbach mobility criteria, Grubler's criteria & its limitations, Grashoff's law, Four bar chain and its inversions, Slider crank chain and its inversions, Double slider crank chain and its inversions. **1.2 Velocity and Acceleration Analysis of Mechanisms using Graphical Approach (mechanisms up to 6 links):** Velocity analysis by instantaneous centre of rotation method and relative velocity method, Rubbing velocities at joints, Mechanical advantage, Acceleration analysis by relative method (Excluding pairs involving Coriolis component).	8
2	**Power transmission drives:** **2.1 Chains:** Chain terminology, Relationship between pitch and pitch circle diameter, Classification of chains, Chordal action, Length of chain. **2.2 Gears:** Introduction to gears and terminology, Types of gears, Law of gearing, Involute and cycloidal tooth profile, Arc of contact and contact ratio, Interference in involute gears, Critical numbers of teeth for interference-free motion, Methods to control interference in involute gears, Static force analysis in spur gears. **2.3 Gear Trains:** Kinematic analysis of simple, compound, reverted, and epicyclic gear trains with spur gear combination.	8
3	**3.1 Basic Concepts of Vibration:** Vibration and oscillation, Causes and effects of vibrations, Vibration parameters - springs, mass, damper, Motion- periodic,	8

	nonperiodic, Degree of freedom, Static equilibrium position, Vibration classification, Steps involved in vibration analysis. **3.2 Free Undamped Single Degree of Freedom Vibration System:** Longitudinal, transverse, and torsional vibration systems, Methods for formulating differential equations by Newton, Energy, Lagrangian and Rayleigh's method.	
4	**Free Damped Single Degree of Freedom Vibration System:** Introduction to different methods of damping, Study and analysis of viscous damped system (under damped, critically damped, over damped; logarithmic decrement), Coulomb's damping.	7
5	**1.1 Forced Single Degree of Freedom Vibratory System:** Analysis of linear and torsional systems subjected to harmonic force excitation and harmonic motion excitation (excluding elastic damper), Critical speed of shaft with single rotor, Balancing of rotating and reciprocating masses (numericals excluded). **1.2 Vibration Isolation and Transmissibility:** Force Transmissibility and isolation, Typical isolators & mounts. **1.3 Vibration Measuring Instruments:** Principle of seismic instruments, Vibrometer, Accelerometer - undamped and damped, Case studies on diagnostics maintenance and condition-based monitoring approach.	8
	Total	**39**

Theory of Machines Laboratory (DJS23MLPC501)	
Sr. No.	**Suggested experiments**
	Group A
1	Velocity analysis of mechanisms by Instantaneous Centre of Rotation (3-5 problems)
2	Acceleration analysis of mechanisms by the Relative method (Problems on pairs involving Coriolis component to be included) (3-5 problems)
3	Plotting of motion graphs for cams and followers (3-5 problems)
4	Layout of cam profiles (3-5 problems)
5	Experimental verification of the principle of Gyroscopic couple
6	Experimental balancing of single and multi-rotor systems
	Group B
1	Determination of the natural frequency of compound pendulum, equivalent simple pendulum system
2	Determination of natural frequency for longitudinal vibrations of helical springs
3	Determination of natural frequency and nodal points for single rotor and two-rotor vibratory systems
4	Experiment on the whirling of shaft
5	Determination of the damping coefficient of any system/media
6	Condition monitoring using an FFT analyser
7	Vibration analysis of mechanical systems using MATLAB/SCILAB/Python

A minimum of ten experiments (all six from the group A list and any four from the group B list) or any other experiment based on the syllabus will be included, which would help the learner apply the concept.
A mini project involving one of the mechanisms, such as straight-line generating mechanisms, offset slider-crank mechanisms, Geneva mechanism, inversions, or others, will also be included.

Books Recommended:

Textbooks:

- P. L. Ballaney, Theory of Machines, Khanna Publishers, 2014
- S. S. Ratan, Theory of Machines, McGraw-Hill Education (India), 2019
- R. S. Khurmi and J. K. Gupta, Theory of Machines, S. Chand Publishing, 2020

Reference Books:

- Thomas Bevan, The Theory of Machines, Pearson Education, 2010
- Jagdish Lal, Theory of mechanisms and machines, Metropolitan Books Co., 2006
- John J. Uicker, Gordon R. Pennock and Joseph E. Shigley, Theory of Machines and Mechanisms, Oxford University Press, 2014
- William T. Thomson, Theory of Vibration with Applications, Pearson Education, 2008
- S. S. Rao, Mechanical Vibrations, Pearson Education, 2018
- S. Graham Kelly, Fundamentals of Mechanical Vibrations, McGraw-Hill Inc. (US), 2000
- Benson H. Tongue, Principles of Vibration, Oxford University Press, 2012
- J. S. Rao and K. Gupta, Theory and Practice of Mechanical Vibrations, New Age International Pvt. Ltd., 2023
- Amitabh Ghosh and A. Kumar Mallik, Theory of Mechanisms and Machines, Affiliated East-West Press, 2011
- Arthur G. Erdman and George N. Sandor, Mechanism Design: Analysis and Synthesis, Volume 1, Pearson Education, 2001
- Jeremy Hirschhorn, Kinematics and Dynamics of Plane Mechanisms, McGraw-Hill, 1962
- W. G. Green, Theory of Machines, Blackie & Son Ltd., 1960

Program: Mechanical Engineering	T.Y. B.Tech	Semester: V
Course: Mechanical Measurements and Metrology (DJS23MCPC502)		
Course: Mechanical Measurements and Metrology Laboratory (DJS23MLPC502)		

Pre-requisite: --

1. Knowledge of basic concepts of Engineering Drawing, Machine Drawing and Manufacturing Processes.

Objectives:

1. To impart knowledge of the architecture of the measurement system.
2. To deliver the working principle of the mechanical measurement system.
3. To acquaint with measuring equipment used for linear and angular measurements.
4. To familiarize with different classes of measuring instruments and the scope of measurement in industry and research.
5. To acquaint with the operations of precision measurement, the instrument/equipment for measurement.

Outcomes: On completion of the course, the learner will be able to:

1. Classify various types of static characteristics and types of errors occurring in the system.
2. Classify and select proper measuring instrument for displacement, strain, pressure, and temperature measurement.
3. Classify and select proper measuring instrument for linear and angular measurement.
4. Demonstrate inspection methods and design of different limit gauges.
5. Demonstrate characteristics of surface texture, screw threads, and gear measurements.

Mechanical Measurements and Metrology (DJS23MCPC502)		
Unit	**Description**	**Duration**
1	**Introduction to mechanical measurements and metrology:** Significance of Mechanical Measurements, Classification of measuring instruments, generalized measurement system, types of inputs: Desired, interfering and modifying Inputs. **Static characteristics:** Static calibration, Linearity, Static Sensitivity, Accuracy, Static Error, Precision, Reproducibility, Threshold, Resolution, Hysteresis, Drift, Span & Range etc. Introduction to Metrology: Fundamental Definitions, Types of Standards, Precision and Accuracy, Errors in measurement: Types of errors, Effect of component errors, Probable errors.	8
2	**Displacement Measurement:** Transducers for displacement, displacement measurement, potentiometer, LVDT, Capacitance Types, Digital Transducers (optical encoder), Nozzle, Flapper Transducer **Strain Measurement:** Theory of Strain Gauges, gauge factor, temperature Compensation, Bridge circuit, orientation of strain gauges for force and torque, Strain gauge-based load cells and torque sensors.	6
3	**Pressure Measurement:** Mechanical Pressure-Measurement Devices, High Pressure Measurements, Bridge man Gauge. Vacuum measurement: Vacuum gauges viz. McLeod gauge, Ionization and Thermal Conductivity gauges.	7

	Flow Measurement: Ultrasonic Flow meter, Magnetic flow meter, The Laser Doppler Anemometer and Hot-Wire and Hot-Film Anemometers. Temperature Measurement: Electrical methods of temperature measurement Resistance thermometers, Thermistors and thermocouples and Pyrometers.	
4	**Linear measurements and Angular Measurement** Design of Gauges: Limits, Fits, Tolerances, Types of Gauges, Taylor's Principle of Limit Gauges, IS 919 for design of gauges. Gear Measurement by Parkinson Gear tester and Gear tooth Vernier Caliper, Screw Thread Measurement: Effective diameter measurement of screw thread by Floating Carriage micrometer.	8
5	**Surface Texture measurement** Surface roughness, Waviness, Roughness Parameter Ra, Rz, RMS etc., working of Tomlinson surface meter, Tally-surf surface roughness tester, Surface roughness symbols.	5
6	**Advances in metrology** Basic concepts of lasers, advantages of lasers, laser interferometers, types, applications. Basic concepts of Coordinate Measuring Machines-constructional features, applications.	5
	Total	**39**

Experiential learning is a powerful way to help mechanical engineering students gain practical knowledge of mechanical measurement and metrology through Laboratory experiments, Field trips, and Case studies.

Laboratory Work: Provide hands-on training for using various measuring tools such as micrometers, vernier calipers, dial indicators, strain gauges, LVDT, Floating carriage micrometer etc. through laboratory experiments.

Industrial Visits: Organize industrial visits to companies that specialize in mechanical measurement and metrology to give students an opportunity to see how these concepts are applied in real-world settings. Encourage students to ask questions and interact with professionals who are working in the field. Encourage students to network with industry professionals and seek out internships.

Case Studies: Use case studies to give students an opportunity to apply their knowledge of mechanical measurement and metrology to real-world problems. Encourage students to work in teams to analyze case studies and develop solutions.

Mechanical Measurements and Metrology Laboratory (DJS23MLPC502)	
Exp.	**Suggested experiments**
1	Calibration and Health Monitoring of Pressure Gauges using Cyber-Physical System.
2	Real-time Pressure Monitoring using IoT-enabled Pressure Sensors.
3	Real-time Torque Monitoring in Rotating Machinery with Predictive Analytic.
4	Wireless Strain Monitoring System using IoT/Study of Strain Gauges.
5	IoT-integrated LVDT Displacement Measurement.
6	Speed measurement using optical or Hall-effect sensors.
7	Speed Measurement using tachometer, optical and magnetic pickup.
8	Gear measurement using Gear tooth Vernier caliper
9	Automated Gear Inspection using Machine Vision and AI
10	Thread Measurement using Floating carriage micrometer

Minimum six experiments from the above-suggested list or any other experiment based on syllabus will be included, which would help the learner to apply the concept learnt.

Assignments:
Minimum five assignments based on syllabus will be conducted or Mini project relevant to the subject, which would help the learner to apply the concept learnt.

Books Recommended:

Text books:

- K. Sawhney and Puneet Sawhney, A Course in Mechanical Measurements and Instrumentation & Control, Dhanpat Rai & Co., 2017.
- A. K. Thayal, Instrumentation & Mechanical Measurements, Galgotia Publications Pvt Ltd, 1999.
- K. J. Hume, Engineering Metrology, Kalyani Publications, 2018.
- I. C. Gupta, A Textbook of Engineering Metrology, Dhanpat Rai Publications, 2018.
- John P. Bentley, Principles of Measurement Systems, Pearson Education, 2004.

Reference Books:

- Ernest O. Doebelin, Measurement Systems: Applications and Design, 5th Edition, McGraw Hill, 2008.
- W. Bolton, Instrumentation and Control Systems, Elsevier, 2023.
- S. P. Venkateshan, Mechanical Measurements, Ane Books, India, 2015.
- R. K. Jain, Mechanical Measurements and Metrology, Khanna Publishers, 1995.
- Anand Bewoor and Vinay Kulkarni, Metrology and Measurement, McGraw Hill, 2017.
- N. V. Raghavendra and L. Krishnamurthy, Engineering Metrology and Measurement, Oxford University Press, 2013.

Program: Mechanical Engineering	T.Y. B.Tech	Semester: V
Course: Fluid Mechanics and Machinery (DJS23MCPC503)		
Course: Fluid Mechanics and Machinery Laboratory (DJS23MLPC503)		

Pre-requisites:

1. Fundamentals of Engineering Mechanics
2. Fundamentals of Applied Mathematics.

Objectives:

1. To provide knowledge on fundamentals of fluid properties, fluid statics, and evaluate fluid kinematic properties.
2. To solve the practical problems based on mass, momentum and energy balance equations.
3. To determine the major and minor losses in a pipe and pipe fittings.
4. To study the performance of hydraulic turbines.
5. To study the performance of centrifugal pumps.

Outcomes: On completion of the course, the learner will be able to:

1. Solve practical problems involving fluid properties, hydrostatic pressure and evaluate fluid kinematic properties.
2. Apply the governing equations for mass, momentum and energy based on Reynolds Transport Theorem and Navier-Stokes equations to flow.
3. Estimate the power required for pumping by considering major and minor losses in flow through pipes.
4. Evaluate the performance of hydraulic turbines.
5. Evaluate the performance of centrifugal pumps.

Fluid Mechanics and Machinery (DJS23MCPC503)		
Unit	**Description**	**Duration**
1	**Properties of Fluid** Definition of Fluid, Newton's law of viscosity, Units and dimensions, physical properties of fluids, pressure measurement, Hydrostatic forces on plane and curved surfaces. **Fluid Kinematics** Eulerian and Lagrangian method of fluid flow description, Flow visualization, Types of flow, Strain rate, Streamline, Streak line, Path lines and Stream tubes, three dimensional continuity equation in Cartesian coordinates, Velocity and acceleration of fluid particles, vorticity, circulation, velocity potential function and stream function.	10
2	**Fluid Dynamics** Reynolds transport theorem, Momentum equation and its application to flow through pipe bend, Navier Stokes equations, exact solution of Navier-Stokes equations for simple flows, Euler's equation of motion along a streamline, Bernoulli's equation and its applications, flow through orifice meter, Venturimeter, Pitot tube.	8
3	**Laminar and Turbulent Flow** Laminar flow through circular pipes, Loss of head and power absorbed in viscous flow; Turbulent flow – Reynolds experiment, Frictional losses in pipe flow; Shear	8

	stress in turbulent flow; major and minor losses (Darcy's and Chezy's equation); Flow through pipes in series, pipes in parallel; branching pipes and equivalent pipe.	
4	**Hydraulic Turbines** Classification of water turbines, Heads and efficiencies, Velocity triangles, Axial, radial and mixed flow turbines, Pelton wheel, Francis turbine and Kaplan turbines – working and design principles.	6
5	**Rotodynamic Machines** Euler's equation, Theory of Rotodynamic machines, Various efficiencies, Velocity components at entry and exit of the rotor, Velocity triangles; **Centrifugal pumps** – Working principle, Work done by the impeller and performance curves, Cavitation in pumps.	7
	Total	**39**

Fluid Mechanics and Machinery Laboratory (DJS23MLPC503)	
Sr. No.	**Experiment Title**
1	Verification of Bernoulli's Theorem (Bernoulli's Apparatus)
2	Determination of coefficient of discharge of a Venturimeter
3	Determination of coefficient of discharge of orifice meter
4	Determination of friction factor for Pipes
5	Determination of minor losses in Pipe system
6	Experiment on Laminar flow in pipes (Reynolds Apparatus).
7	Verification of impulse momentum principle
8	Determination of efficiency of a centrifugal pump
9	Determination of overall efficiency of an impulse turbine (Pelton Wheel)
10	Determination of overall efficiency of a Francis / Kaplan turbine
11	Simulation of Flow over an aerofoil in a Wind Tunnel

A minimum of eight experiments from the above-suggested list would help the learner to apply the concept learnt.

Books Recommended:

Textbooks

- R K Bansal: A Textbook on Fluid Mechanics and Hydraulic Machines, Laxmi Publications, New Delhi, 2019.
- S. K. Som and Gautam Biswas: Introduction to Fluid Mechanics and Fluid Machines, Mc Graw Hill Publication, New Delhi, 2017.

Reference Books:

- Frank W. White: Fluid Mechanics, McGraw Hill Education, 2021.
- Yunus A. Cengel and John M Cimbala: Fluid Mechanics, McGraw Hill Education, 2024.
- Bruce Munson, John Wiley and sons: Fundamentals of Fluid Mechanics, Wiley, 2012.
- Fox and McDonald: Introduction to Fluid Mechanics, Wiley, 2020.
- Russel C. Hibbeler: Fluid Mechanics, Pearson, 2023.

Prepared by Checked by Head of the Department Principal

Program: Mechanical Engineering	T.Y. B.Tech	Semester: V
Course: Industrial Electronics (DJS23MCMD501)		
Course: Industrial Electronics Laboratory (DJS23MLMD501)		

Pre-requisite:

1. Knowledge of essential electronic devices like Semiconductor Diodes.

Objectives:

1. To understand power electronic switches and circuits in industrial applications.
2. To Analyse operational amplifiers and digital circuits for signal processing.
3. To Introduce microcontrollers and their role in industrial electronics.
4. To Study industrial sensors and motors for automated systems.
5. To Implement industrial electronics concepts through hands-on experiments.

Outcomes: On completion of the course, the learner will be able to:

1. Describe and Explain electronic switch construction, working principles, and applications.
2. Design and select rectifiers and inverters for DC and AC motor speed control.
3. Apply digital circuits in industrial control applications.
4. Develop circuits using operational amplifiers and timer IC555 for signal processing.
5. Evaluate and recommend appropriate sensors and motors for various industrial applications.

Industrial Electronics (DJS23MCMD501)		
Unit	**Description**	**Duration**
1	**Semiconductor Devices:** **Review of Semiconductor Devices**: Diodes, Zener Diodes, LEDs, Photodiodes **Electronics Switches**: SCR (V-I Characteristics, Triggering, Turn-off Mechanisms), GTO, Triac-Diac Circuit Applications **Power Transistors**: BJT, MOSFET, IGBT – Construction, Characteristics, and Industrial Applications **Comparison of Power Devices**: SCR vs. Triac vs. MOSFET vs. IGBT **Applications**: Industrial Power Control, Soft Starters, Speed Controllers	08
2	**Phase-controlled rectifiers and Bridge inverters:** **Phase-Controlled Rectifiers**: Half-wave and Full-wave Rectifiers using SCR (Resistive Loads) **H-Bridge and PWM Control**: DC Motor Speed Control using Power Electronics **Single-phase & Three-phase Inverters**: Working Principles, Pulse Width Modulation (PWM) Techniques **Closed-loop Speed Control**: Block Diagram and Implementation for DC & AC Motors	08
3	**Element of Signal Conditioning:** **Amplifiers & Filters**: Types (Inverting, Non-Inverting, Buffer, Comparator, Instrumentation Amplifier), Active Filters **IC-555 Timer**: Modes of Operation (Monostable, Astable Multivibrator), PWM Generation **Analog Signal Processing**: Attenuators, Signal Amplification, Noise Reduction **Application in Industrial Systems**: Temperature Sensors, Motor Feedback Control	08

4	**Digital Logic and Microcontrollers:** **Logic Gates & Boolean Algebra**: TTL vs. CMOS Logic Families, Multiplexer & Demultiplexer Applications **Microcontrollers vs. Microprocessors**: Features, I/O Operations, Interrupts, and Timer Modules **Analog to Digital Conversion (ADC) & Communication Protocols**: UART, SPI, I2C **Case Study & Industrial Applications**: Temperature Measurement, Speed Control, Solenoid & Relay Control **,** AI-driven Automation and Smart Manufacturing	08
5	**Sensors and Motors:** **Industrial Sensors**: Displacement, Temperature, Acceleration, Pressure, Optical Sensors **Motor Technologies**: DC Motors, AC Induction Motors, Stepper Motors, BLDC Motors, Servo Motors, Linear Actuators **Speed Control Methods**: Microcontroller-based Speed Control for DC and AC Motors **Motor Selection and Sizing**: Duty Cycles, Power Rating Considerations **Case Study**: Motors in Pumps, Conveyors, CNC Machines, and Robotics	07
	Total	**39**

Industrial Electronics Laboratory (DJS23MLMD501)	
Exp.	**Suggested experiments**
1	Dynamic analysis of MOSFET / IGBT as a switch devices
2	Evaluation of a Single phase Bridge inverter with rectifier load
3	Design and simulation of OPAMP as integrator
4	Implementing the study of gates and Logic Operations like NOT, AND, OR
5	Realization of basic gates using universal gates
6	Designing of an Light dimmer circuit using Diac-Triac
7	Designing a mechanism of Speed control of DC motor
8	Simple microcontroller-based applications like Temp Measurement/ Speed Measurement using Proximity
9	Speed control of the induction motor
10	Speed control of the BLDC motor
11	Study of Sensors kit.

Minimum of eight experiments from the above-suggested list or any other experiment based on syllabus will be included, which would help the learner to apply the concept learnt.

Books Recommended:

- Rashid M.H., Power Electronics: Circuits, Devices & Applications, 4th Edition. Pearson, New York, NY, USA; 2023
- Boylestad R.L., Nashelsky L., Electronic Devices and Circuit Theory, 11th Edition. Pearson, New York, NY, USA; 2020
- Mohan N., Undeland T., Robbins W., Power Electronics: Converters, Applications, and Design, 3rd Edition. Wiley, Hoboken, NJ, USA; 2002.
- Jain R.P., Modern Digital Electronics, 4th Edition. Tata McGraw-Hill, New Delhi, India; 2009.
- Malvino A.P., Leach D.P., Digital Principles and Applications, 7th Edition. Tata McGraw-Hill, New Delhi,

India; 2011.

- Davies J.H., MSP430 Microcontroller Basics. Newnes, Oxford, UK; 2008.
- Ogata K., Modern Control Engineering, 5th Edition. Prentice-Hall, New York, NY, USA; 2010.
- Raghavendra N.V., Krishnamurthy L., Engineering Metrology and Measurements. Oxford University Press, Oxford, UK; 2013.
- Bolton W., Instrumentation and Control Systems, 2nd Edition. Elsevier, Amsterdam, Netherlands; 2015.

Program: Mechanical Engineering	T.Y. B.Tech	Semester: V
Course: Database Management System Laboratory (DJS23MLMD502)		

Pre-requisite:

1. Computer Basics

Objectives:

1. To introduce the students to database systems management, emphasizing how to design, organize, maintain, and retrieve information efficiently and effectively from a database.

Outcomes: On completion of the course, the learner will be able to:

1. Design an optimized database.
2. Construct SQL queries to perform operations on the database.
3. Demonstrate the concept of transaction, concurrency, and recovery.

Database Management System Laboratory (DJS23MLMD502)		
Unit	**Description**	**Duration**
1	**Introduction Database Concepts:** Introduction, Characteristics of databases, File system v/s Database system, Users of Database system, Schema and Instance, Data Independence, DBMS system architecture, Database Administrator.	03
2	**Entity–Relationship Model:** Introduction, Entity types, Entity sets, weak and strong entity, types of attributes, keys, and relationships, Relationship constraints: cardinality and participation, Generalization and specialization, Mapping the ER Model to the Relational Model	05
3	**Structured Query Language (SQL):** Overview of SQL, Data Definition Commands, Data Manipulation commands, Integrity constraints - key constraints, Domain Constraints, Referential integrity, check constraints, Data Control commands, Transaction Control Commands, Set and String operations, aggregate function - group by, having, Views in SQL, joins, Nested and complex queries, Triggers	12
4	**Relational–Database Design:** Pitfalls in Relational-Database designs, Concept of normalization, Function Dependencies, Normal Forms- 1NF, 2NF, 3NF, BCNF	03
5	**Transaction Management and Recovery:** Transaction Concept, ACID properties, Transaction States, Implementation of atomicity and durability, Concurrent Executions, Serializability, Concurrency Control Protocols: Lock-based, Timestamp based, Log based recovery	03
	Total	**26**

Database Management System Laboratory (DJS23MLMD502)	
Exp.	**Suggested Experiments**
1	To draw an ER diagram for a problem statement and map the ER diagram to relations.
2	introductions to SQL & Mechanical Data
3	Data Handling from PSG Handbook
4	Bill of Materials (BoM) Structure

5	Normalization of Mechanical Data
6	Design a Fastener Lookup Tool (Mini Project – Part 1)
7	Query Interface for Fastener Lookup (Mini Project – Part 2)
8	Machine Maintenance Database
9	Performance Tracking Database for Equipment
10	Case Study for a specific product/process a) Schema Design b) Database instance on cloud c) Build visualizations using SQL Queries.
11	DBMS and Industry 4.0 (Demo/Research-based

Minimum eight experiments from the above suggested list or any other experiment based on syllabus will be included, which would help the learner to apply the concept learnt.

Books Recommended:

Textbooks:

- Korth, Silberschatz, Sudarshan, "Database System Concepts", 7th Edition, McGraw – Hill, 2019.
- Elmasri and Navathe, "Fundamentals of Database Systems", 7th Edition, Pearson Education, 2021.
- G Peter Rob and Carlos Coronel, "Database Systems Design, Implementation and Management", 5th Revised Edition, Thomson, 2002
- G. K. Gupta, "Database Management Systems", 3rd Edition, McGraw – Hill, 2018

Reference Books:

- P.S. Deshpande, "SQL and PL/SQL for Oracle 10g, Black Book", Dreamtech Press, 2012
- Sharanam Shah, Vaishali Shah, "Oracle for Professional", 1st Edition, Shroff Publishers & Distributers Private Limited, 2008
- Raghu Ramakrishnan and Johannes Gehrke, "Database Management Systems", 3rd Edition, McGraw – Hill, 2014.
- Patrick Dalton, "Microsoft SQL Server Black Book", 11th Edition, Coriolis Group, U.S., 1997
- Lynn Beighley, "Head First SQL", 1st Edition, O'Reilly Media, (28 August 2007)

Program: Mechanical Engineering	T.Y. B.Tech	Semester: V
Course: Reliability Engineering (DJS23MCPE511)		
Course: Reliability Engineering Laboratory (DJS23MLPE511)		

Pre-requisite:

1. Basics of Probability and Statistics

Objectives:

1. To impart a basic understanding of probability and statistical techniques used in reliability engineering.
2. To make the learner aware of applications of probability distributions in modeling and analyzing failure data.
3. To be familiar with the techniques used in system reliability modeling and analyze warranty data.
4. To provide a basic understanding of the use of probabilistic approaches to design components and predict reliability
5. To introduce the concepts of reliability testing.

Outcomes: On completion of the course, the learner will be able to:

1. Use the basics of reliability and its measures for analyzing components and systems.
2. Apply probability distributions to estimate reliability functions such as reliability, CDF, PDF, hazard rate, etc.
3. Develop system reliability models to solve system reliability problems and analyze warranty data.
4. Apply probabilistic approaches for component design and reliability prediction.
5. Select a suitable reliability testing method

Reliability Engineering (DJS23MCPE511)		
Unit	**Description**	**Duration**
1	**Basic Reliability Mathematics** **Probability:** Standard definitions and concepts; Conditional Probability, Baye's Theorem. **Reliability Concepts**: Reliability Engineering in the 21st Century, Reliability definitions, Importance of Reliability, Reliability objectives. **Failure Data Analysis:** PDF, Reliability function, CDF, Moments of time to failure - MTTF, MTBF, the median time to failure, mode, skewness, kurtosis, variance and standard deviation, Hazard rate function, Bathtub curve.	7
2	**Probability Distributions** Discrete probability distribution - Binomial distribution and Poisson distribution. Continuous Probability Distributions – Weibull, exponential, normal (Gaussian), and lognormal. Concept of confidence interval.	7
3	**System Reliability:** System Configurations: Series, parallel, mixed configuration, k out of n structure, and Complex systems. Success path method, Decomposition method. Tie-set and Cut-set methods. Logic diagrams. **Reliability Improvement:** Redundancy Techniques: Element redundancy, Unit redundancy, and Standby redundancies.	8
4	**System Reliability Modeling and Warranty Analysis** Failure Modes and Effects Analysis (FMEA), and Fault Tree Analysis (FTA). Product warranty and reliability.	7

	Probabilistic Design: Design for Reliability, Reliability models for probabilistic design, Relationship between reliability, Factor of safety, and variability.	
5	**Product Life Cycle Assessment and Sustainable Development Goals** **Maintainability:** Types of maintenance, and Models for maintenance data. **Availability:** Types, Markov chains. **Reliability Testing:** Stress strength interaction, Accelerated Life Testing (ALT), Highly Accelerated Life Testing (HALT), and Highly Accelerated Stress Screening (HASS). Handbook-based reliability predictions. **Product Life Cycle Costing (LCC)**: Concept, LCC models, Product recycling, Resource optimization, and Circular economy. Human reliability and sustainability. **Reliability Engineering and Sustainable Development Goals (SDG's)**: Renewable Energy Systems, Reliability-Centered Maintenance (RCM) in Waste Management Systems, Water Supply and Sanitation System, Sustainable Manufacturing, Food Supply Chain Reliability in Climate-Vulnerable Regions.	10
	Total	**39**

Reliability Engineering Laboratory (DJS23MLPE511)	
Sr. No	**Suggested Experiments/ Exercises**
1	Reliability data collection, sorting, classification, Pareto analysis/ bar chart plotting (paper clips experiments). Plotting reliability characteristics for a given data set.
2	Select the best-fit probability distributions for reliability modeling using a suitable approach (Use data from paper clips experiments).
3	Reliability analysis of engineering systems using Reliability Block Diagrams (RBD).
4	Reliability and safety evaluation of a mechanical system using Fault Tree Analysis (FTA).
5	Failure Mode and Effects Analysis (FMEA) of a mechanical system such as CNC machine using MIL-STD-1629A Standard.
6	Reliability evaluation of a two-state mechanical system using Markov chains or Monte Carlo Simulation.
7	Failure prediction and warranty cost estimation for an automotive alternator using physics of failure and warranty data analysis.
8	Reliability allocation for a hydraulic brake system using ARINC/ AGREE/ Feasibility-of-Objectives/ and Integrated Factor Methods
9	Handbook based reliability predictions - FIDES, 217+, Bellcore/ Telcordia SR-332, ANSI/ VITA51.1, NSWC-11, or GJB/z 299 (any one).
10	Analyse life testing data for the following cases: • Life testing with censoring. • Life testing with replacement. • Life testing without replacement.
12	Environmental stress screening (e.g., temperature and humidity simulation, thermal stress cycling) to assess product and material durability under different environmental conditions.
13	Human Reliability Assessment (HRA) in the operation and maintenance of mechanical systems using the Human Error Assessment and Reduction Technique (HEART).

The above experiments/ exercises should be performed using a suitable software package/ programming language whenever required. The first 6 experiments are mandatory. Any two from experiment no. 7 to 13 can be performed.

Books Recommended:

Textbooks:

- C. E. Ebeling, An Introduction to Reliability and Maintainability Engineering, Waveland Press Inc., 2019.
- K. C. Kapur, and M. Pecht, Reliability Engineering, Wiley, 2014.
- B. S. Dhillon, Design Reliability: Fundamentals and Application, CRC Press, 1999.
- V. N. A. Naikan, Reliability Engineering and Life Testing, PHI Learning, 2008.
- L. S. Srinath, Reliability Engineering, Affiliated East-West Press (P) Ltd., 2016.

Reference Books:

- E. Balagurusamy, Reliability Engineering, Tata McGraw Hill, 2017.
- M. Modarres, K. Kaminsky, and V. Krivstov, Reliability Engineering and Risk Analysis – A Practical Guide, CRC Press, Taylor and Francis Group, 2017.
- P. D. T. O'Conner, Practical Reliability Engineering, John Wiley and Sons, 2012.
- G. Yang, Life cycle reliability engineering, John Wiley and Sons, 2007.
- B. S. Dhillon, Engineering Maintainability, Prentice Hall of India, 1999.

Web References:

- Statistical Learning in Reliability Analysis (https://onlinecourses.nptel.ac.in/noc22_cs120/preview)
- Introduction to Reliability Engineering (https://onlinecourses.nptel.ac.in/noc23_ge20/preview)

Program: Mechanical Engineering	T.Y. B.Tech	Semester: V
Course: Renewable Energy Systems (DJS23MCPE512)		
Course: Renewable Energy Systems Laboratory (DJS23MLPE512)		

Pre-requisite:

1. Knowledge of Energy science, Energy sources.
2. Fundamentals of Thermodynamics, Heat Transfer and Fluid mechanics.

Objectives:

1. To study working principles of various renewable energy sources and their utilities.
2. To study the economics of harnessing energy from renewable energy sources.
3. To gain the knowledge of renewable energy conversion systems design.
4. To develop skills to analyse industry and domestic applications of RES.

Outcomes: On completion of the course, the learner will be able to:

1. Explain the need for different renewable energy sources.
2. Discuss importance of renewable energy sources.
3. Discuss various renewable energy sources in the Indian context.
4. Calculate and analyse utilization of solar and wind energy.
5. Illustrate design of biogas plant.
6. Explain basics of hydrogen energy.

Renewable Energy Systems (DJS23MCPE512)		
Unit	**Description**	**Duration**
1	**Introduction to Energy Sources** Renewable and non-renewable energy sources, Energy policy and sustainability, Energy Consumption as a measure of Nation's development; Strategy for meeting the future energy requirements, Global and National scenarios, Prospects of renewable energy sources, Present status and current installations, Emerging and future energy technologies, various MNRE programmes.	4
2	**Solar Energy** Merits and demerits, Solar radiation - beam and diffuse radiation, solar constant, earth sun angles, attenuation and measurement of solar radiation, local solar time, derived solar Angles, sunrise, sunset and day length, Principle of solar energy conversion. Types of Solar Energy Technologies. Components of a Solar Power System. Solar Energy collection devices and Classification: Flat plate collectors, concentrating collectors, Solar air heaters-types, solar driers, storage of solar energy-thermal storage, solar pond, solar water heaters, solar distillation, solar still, solar cooker, solar heating & cooling of buildings, Solar Photovoltaic systems & applications. Solar Energy in the Global Context. Future of Solar Energy.	9
3	**Wind Energy** Principle of wind energy conversion; Basic components of wind energy conversion systems; Wind turbine technologies, wind mill components, various types and their constructional features; design considerations of horizontal and vertical axis wind machines: analysis of Aerodynamic forces acting on wind mill blades and estimation of	8

	power output; wind data and site selection Considerations. Global Wind Energy Development. Future Trends in Wind Energy.	
4	**Energy from the ocean:** Ocean Thermal Electric Conversion (OTEC) systems like open cycle, closed cycle, Hybrid cycle, prospects of OTEC in India. Energy from tides, basic principle of tidal power, single basin and double basin tidal power plants, advantages, limitation and scope of tidal energy. Wave energy and power from wave, wave energy conversion devices, advantages and disadvantages of wave energy. **Geothermal Energy:** Estimation and nature of geothermal energy, geothermal sources and Resources like hydrothermal, geo-pressured hot dry rock, magma. Advantages, disadvantages and Application of geothermal energy, prospects of geothermal energy in India.	10
5	**Energy from Biomass:** Biomass conversion technologies, Biogas generation plants, classification, advantages and disadvantages, constructional details, site selection, digester design consideration, filling a digester for starting, maintaining biogas production, Fuel properties of biogas, utilization of biogas. **Hydrogen Energy:** Methods of Hydrogen production, Hydrogen Storage, Fuel Cells and Types of Fuel Cells.	8
	Total	**39**

Renewable Energy Systems Laboratory (DJS23MLPE512)	
Sr. No.	**Experiment Title**
1	Measurement of Solar Radiation (Irradiance) Using a Pyranometer.
2	Study of Solar Energy Potential for a Specific Location.
3	Study on the Impact of Climate Change on Solar Energy Generation.
4	Performance Study of a Flat Plate Solar Collector.
5	Study of Comparison of Solar Collectors (Flat Plate vs. Evacuated Tube vs. Parabolic).
6	Study of Solar Photovoltaic Power Generation.
7	Study of a Solar-Powered Desalination System.
8	Study of Vertical Axis vs. Horizontal Axis Wind Turbines.
9	Performance Analysis of a Small Wind Turbine.
10	Study of Biogas Production from Organic Waste.
11	Study of Bioethanol Production from Biomass.

A minimum of eight experiments from the above-suggested list or any other experiment based on the syllabus will be included, which would help the learner to apply the concept.

Books Recommended:

Text Books:

- G. D. Rai, Non-conventional energy sources, 6th edition, Khanna Publishers, 1988.
- S. P. Sukhatme, and J. K. Nayak, Solar Energy: Principles of Thermal Collection and Storage, 4th edition, TMH, 2017.
- H. P. Garg, and Jai Prakash, Solar Energy: Fundamentals and Applications, 1st revised edition, TMH, 1997.
- Joshua Earnest, Wind Power Technology, PHI Learning, 2014.
- J. W. Twidell, and Anthony D. Weir, Renewable Energy Sources, ELBS Publication, 1986.
- D. Begamudre, Energy Conversion Systems, R. New Age International (P) Ltd., Publishers, 1998.

- C. S. Solanki, Solar Photovoltaics: Fundamentals, Technologies and Applications, 3rd Edition, PHI Learning, 2013.

Reference Books:

- D. D. Hall and R. P. Grover, Biomass Regenerable Energy, John Wiley, New York, 1987.
- Mukund R. Patel, Wind and Solar Power Systems, 2nd edition, CRC Press, 2005.
- J. F. Manwell, J. G. McGowan, and A. L. Rogers, Wind Energy Explained: Theory, Design and Application, John Wiley and Sons, 2009.

Program: Mechanical Engineering	T.Y. B.Tech	Semester: V
Course: Advanced Materials and Processes (DJS23MCPE513)		
Course: Advanced Materials and Processes Laboratory (DJS23MLPE513)		

Pre-requisite: Knowledge of

1. Engineering Materials.
2. Manufacturing Processes.

Objectives:

1. To provide the comprehensive exposure to new and advanced materials such as smart materials, high temperature materials, nanomaterials, energy storage materials, biomaterials and advanced functional materials, etc.
2. To make the students familiarize with the development of new materials and processes to cater the application requirements of real world.

Outcomes: On completion of the course, the learner will be able to:

1. Comprehend stimuli-response behavior in smart materials and apply the principles of smart materials in the development of integrated systems such as mechatronic systems and structural health monitoring systems.
2. Analyse and design smart materials for their applications in sensors, actuators, self-healing mechanism.
3. Recognize the need for high temperature material, Biomaterials and select an appropriate material for their application.
4. Correlate structure, properties and synthesis of functional and nanostructured materials and analyse the materials used for energy storage, harvesting and hydrogen storage and their application in sustainable energy systems.
5. Apply advanced manufacturing techniques to produce smart and novel materials for diverse engineering applications.

Advanced Materials and Processes (DJS23MCPE513)		
Unit	**Description**	**Duration**
1	**Smart Materials – Part I** Introduction: Concept of smart and intelligent materials, Overview and classification, Active and passive smart materials, HBLS and LBHS materials, Applications for sensors and actuators (mechatronic aspect). Shaper Memory Alloys: Brief history, Shape memory materials and their properties, One way and two-way shape memory effect, Pseudo elasticity and pseudo plasticity effect, Examples, Applications and related manufacturing processes. Piezoelectric Materials: Piezoelectricity, Materials- processing & properties, piezoelectric effects, Constituent equations and Applications. Structural Health Monitoring: Integration of smart materials into structures. Applications of SMA and Piezoelectric in constructions, vibrations isolation systems, dampers, restoration of old structures, bimorphs, inkjet printers, transformers, transducers etc.	08
2	**Smart Materials – Part II** Brief overview of Related materials – Composition, properties & processing, Effects, Constituting or governing equations and Industrial applications associated with following smart materials. Magnetorheological & Electrorheological fluids.	08

	Magnetostrictive and Electrostrictive materials. Electroactive polymers (EAP's): IPMC's, Dielectric polymers, Conductive polymers etc. Soft matter. Smart composites: Active fiber composites/smart polymer matrix composites Applications: Automotive clutches, brakes, animatronics, human machine interface, biological muscles, microsurgery etc	
3	**High Temperature Materials & Super Alloys** Introduction, Materials behavior at high temperature, Characteristics of high temperature materials, their composition, properties and applications (Steels, intermetallic, ceramics and composites). Super Alloys: Common features, synthesis and applications of Ni and Co based super alloys Biomaterials: Introduction, structure–property relationships of biomaterials, classes and their biocompatibility, and the design principles for implants, prosthetics, drug delivery systems, and tissue engineering etc.	08
4	**Functional Materials, Nanomaterials and Energy Storage** Functional Materials: Classes, Properties, and applications of functionally graded materials and multifunctional materials for additive manufacturing, self-healing materials, and chromogenic material. Nanomaterials: Concept, Classification, Size effect on structural and functional properties, Top-down and Bottom-up approach, Special nanostructures (Fullerene, Graphene, Carbon nanotubes etc) and their application, Nanocomposites and Nanotechnology. Energy storage: Energy harvesting, Hydrogen Technology: Production and storage of cryogenic, gaseous and solid hydrogen	08
5	**Processing of Advanced Materials** Manufacturing of smart and new materials by additive manufacturing, powder metallurgy, vacuum arc melting, mechanical alloying, single crystal growth, rapid solidification processing, sol-gel, physical and chemical vapour deposition technique etc.	07
	Total	**39**

Advanced Materials and Processes Laboratory (DJS23MLPE513)

Assignments based on syllabus.
Case study or literature based presentation/seminar.
Mathematical modelling and simulation of smart and new materials based systems and devices.

Books Recommended:

Text Books:

- Chander Prakash, Sunpreet Singh, and J. Paulo Davim, Functional and Smart Materials, CRC Press, 2021.
- Rachid Bouhfid & Abou el Kacem Qaiss & Mohammad Jawaid, Polymer Nanocomposite-Based Smart Materials: From Synthesis to Application, Elsevier, 2020.
- Masoud Mozafari, Handbook of Biomaterials Biocompatibility, Elsevier, Woodhead Publishing, 2020.
- Maria Rosa Aguilar, Julio San Roman, Smart Polymers and Their Applications, Elsevier, Woodhead Publishing, 2019.
- Anca Filimon, Smart materials- Integrated Design, Engineering Approaches, and Potential Applications, CRC Press, 2019.

- Kuan Yew Cheong, Giuliana Impellizzeri and Mariana Fraga, Emerging Materials for Energy Conversion and Storage, Elsevier, 2018.
- Ying-Pin Chen, Sajid Bashir, Jingbo Louise Liu, Nanostructured Materials for Next-Generation Energy Storage and Conversion, Springer, 2017.
- Qing Li, Yiu-Wing Mai, Biomaterials for Implants and Scaffolds, Springer, 2017.
- Jayantha Ananda Epaarachchi, Gayan Chanaka Kahandawa, Structural Health Monitoring Technologies and Next-Generation Smart Composite Structures, CRC Press, 2016.
- Xu Hou, Design, Fabrication, Properties, and Applications of Smart and Advanced materials, CRC Press, 2016.
- David Julian McClements, Nano Particle and Micro Particle Based Delivery Systems, CRC Press, 2015.
- Yoseph Bar-Cohen, High Temperature Materials and Mechanisms, CRC Press, 2014.
- William G. Fahrenholtz, Eric J. Wuchina, William E. Lee, Yanchun Zhou, Ultra-High Temperature Ceramics: Materials for Extreme Environment Applications, Wiley, 2014.
- C. Mauli Agrawal, Joo L. Ong, Mark R. Appleford, Gopinath Mani, Introduction to Biomaterials: Basic Theory with Engineering Applications, Cambridge University Press, 2014.
- Rani Elhajjar, Valeria La Saponara, Anastasia Muliana, Smart Composites: Mechanics and Design, CRC Press, 2013.
- Mel Schwartz, Smart Materials, CRC Press, 2009.

Web Resources:

- Prof. Jayanta Das, Advanced Materials and Processes, NPTEL Course, IIT Kharagpur.
- Prof. Kaushik Pal., Selection of Nanomaterials for Energy Harvesting and Storage Application, NPTEL Course, IIT Roorkee.
- Bhattacharya B, Smart Materials and Intelligent System Design, NPTEL Course, IIT Kanpur.
- Prof. Indranil Ghosh, Cryogenic Hydrogen Technology, NPTEL Course, IIT Kharagpur.

Program: Mechanical Engineering	T.Y. B. Tech	Semester: V
Course: Automotive Prime Movers (DJS23MCPE514)		
Course: Automotive Prime Movers Laboratory (DJS23MLPE514)		

Pre-requisites:

1. Thermodynamics.
2. Engineering materials.

Objectives:

1. To comprehend the functions of components of an internal combustion engine and its systems.
2. To familiarise with different systems in SI and CI engines.
3. To analyze engine performance and emissions.
4. To acquaint with modern hybrid and electric powertrains.

Outcomes: On completion of the course, the learner will be able to:

1. Apply the fundamentals of thermodynamics and analyze engine cycles.
2. Demonstrate the working systems of spark ignition & compression ignition engines.
3. Analyse various engine performance parameters and emission control strategies.
4. Evaluate the energy flow and control in hybrid powertrain systems.
5. Evaluate the energy flow and control in electric powertrain systems.

Automotive Prime Movers (DJS23MCPE514)		
Unit	**Description**	**Duration**
1	**Introduction** Classification, components and materials of I.C. Engines, Four stroke, two stroke engines, Fuel-air cycles and their analysis, Actual cycle, Valve timing diagram. Cooling systems and their comparison: Air cooling, Liquid cooling, Troubleshooting aspects, Types of lubricants and their properties, SAE rating of lubricants, Types of lubrication systems and their applications. **Spark Ignition (SI) Engines** **Fuel Injection system:** Air-Fuel mixture requirements for steady state and transient operations. Types of fuel injection systems. Engine Control Unit, Sensors and actuators, Open loop and closed loop modes. Analysis of fuel injection parameters. **Ignition systems:** Battery ignition system, Magneto ignition system, Electronic ignition systems. **Combustion:** Combustion phenomenon in SI Engines, Pressure-crank angle diagram, abnormal combustion, Factors affecting combustion and detonation, Types of combustion chambers. Troubleshooting aspects.	9
2	**Compression Ignition (CI) Engines** **Fuel Injection Systems:** Types of fuel injection systems, Types of nozzles, role of fuel atomization and spray structures, electronically controlled unit fuel injection system. Load and speed control of CI engines. Analysis of fuel injection parameters. **Combustion:** Combustion phenomenon in CI engines, Stages of combustion, Delay period, Knocking, Pressure-Crank angle diagram, Factors affecting combustion and knocking, Types of combustion chambers. Troubleshooting aspects.	8

3	**Engine Performance and Emissions** Measurement and analysis of engine performance parameters, Performance characteristic of SI and CI engines, Effect of load and speed on engine performance & heat balance sheet. Bharat Stage VI emission norms, emission control systems. Alternative fuels: Ethanol, Bio-diesel, CNG, LPG, Hydrogen, Synthetic fuels - Merits, demerits and engine modifications. **Supercharging/Turbo-charging:** Objectives and limitations, Methods, types and different arrangements of superchargers and turbochargers. **Recent developments:** Cam-less engine, VVT, Stratification in GDI engine, LHR engine, HCCI engine & six-stroke engine.	9
4	**Hybrid Powertrain** Hybrid powertrain architecture, Hybrid powertrain performance - Series architecture and Parallel architecture, Hybrid power system components, Degree of hybridization, Regenerative braking, Effect of driving cycles on hybrid performance, Hybrid powertrain control algorithms and thermal management.	8
5	**Electric Powertrain** Introduction to components used in electric vehicles, Energy storage systems and their characteristics. Battery energy and thermal management systems. Types of motors employed in EVs. Configuration and control of motor drives. Drive system efficiency calculations.	7
	Total	**39**

Automotive Prime Movers Laboratory (DJS23MLPE514)	
Sr. No.	**Experiment Title**
	Study-Type/ Case-Study-based Experiments
1	Study of components of an internal combustion engine.
2	Study of fuel injection system in SI engines.
3	Study of fuel injection system in CI engines.
4	Study of electric motor test methods.
5	Perform a case study on the hybrid and electric vehicles.
	Numerical Analysis/ Simulation-based Experiments
6	Analysis of supercharging and turbo charging of I C engines.
7	Simulation of engine parameters on any simulation software (LOTUS/Ricardo/Diesel-RK)
8	Simulation of ICE powertrain on MATLAB Simulink software.
9	Simulation of electric powertrain on MATLAB Simulink software.
10	Simulation of hybrid powertrain on MATLAB Simulink software.
11	Model and compare the energy efficiency of ICE vehicles, Hybrid vehicles and BEVs under similar conditions.
	Performance-Based Experiments
12	Experimental estimation and validation of valve timing for four stroke SI / CI Engine.
13	Load Test on CI engine.
14	Speed Test on SI engine.
15	Heat Balance test on SI or CI engines
16	Experimental determination of friction power of multi-cylinder SI engine using Morse test.
17	Experimental determination of Air fuel ratio and volumetric efficiency of the engine.

A minimum of nine experiments from the above-suggested list or any other experiment based on the syllabus will be included, which would help the learner to apply the concept.

Books Recommended:

Textbooks:

- Ganesan V., Internal Combustion Engines, McGraw Hill, 4th Edition, 2020.
- Mathur and Sharma, Internal Combustion Engines, Dhanpat Rai Publications, 2018.
- R K Rajput, Internal Combustion Engines, Laxmi Publications, 3rd Edition, 2016.
- Tom Denton, Automotive Electrical and Electronic Systems, Routledge, 5th Edition, 2017.
- Lowry J., Electric vehicle technology explained, 2nd edition, Wiley, 2012.

Reference Books:

- Mehrdad Ehsani, Yimi Gao, Sebastian E. Gay, and Ali Emadi, Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Practice, CRC Press, 2018.
- Chris Mi, M. Abul Masrur, Hybrid Electric Vehicles: Principles and Applications with Practical Perspectives, John Wiley & Sons Ltd, 2018.

Program: Mechanical Engineering	**T.Y. B.Tech**	**Semester: V**
Course: Adhesive Technology (DJS23MCPE515)		
Course: Adhesive Technology Laboratory (DJS23MLPE515)		

Pre-requisites:

1. Basics of Mechanical Engineering.
2. Probability and Statistics.
3. Basics of Physics and Chemistry.

Objectives:

1. To impart a basic understanding of adhesives and the bonding process.
2. To make the learner aware of applications of adhesives in improving the reliability of threaded joints and assemblies.
3. To be familiar with different dispensing methods.
4. To provide a basic understanding of the shelf life and various failure modes observed in shelf life.
5. To explain the use of test standards and certification processes of ISO 10964, ISO 10123, and ISO 16047.

Outcomes: On completion of the course, the learner will be able to:

1. Use the concept of adhesion and bonding processes in various applications.
2. Apply suitable adhesives in threaded joints and assemblies and estimate/ predict its performance.
3. Demonstrate different dispensing techniques and select suitable dispensing techniques.
4. Use a suitable method to estimate the reliability of assembly/ joints.
5. Develop a system reliability model using FMEA/ FTA and identify root causes of the failures.
6. Use test standards and certification processes provided in ISO 10964, ISO 10123, and ISO 16047.

Adhesive Technology (DJS23MCPE515)		
Unit	**Description**	**Duration**
1	**Basics of Adhesives** Introduction, Definition of adhesives, Basics of bonding, Adhesion, Cohesion, Bonding process – surface preparation, cleaning, application of adhesive, curing process, performance, and testing cured adhesive strength, Effect of environment on cured bondline.	6
2	**Threaded Assemblies** Threaded fastener mechanics, Clamping loads, Controlled clamp loads, Fastener failures, Threadlockers, Application of adhesives, Testing, and validation, Pipe joints, Thread sealing, Retaining for cylindrical assembly.	7
3	**Gasketing and Bonding** Types of gasketing, Materials used for gasketing, Issues with gasketing, Adhesive applications for gasketing, Types of bonding, Performance of gasketing with and without application of adhesive bonding. **Dispensing:** Why dispensing equipment? Dispensing technology – pressure/ time dispensing, volumetric dispensing, peristaltic pump, progressive cavity pump, Manual dispensing, Automatic dispensing, Equipment selection.	9
4	**Troubleshooting** Failure modes, causes, mechanisms, Root cause analysis, Failure mode analysis, Fault tree analysis, Failure modes and effects analysis, Fishbone diagram.	10

	Shelf Life: Definition of shelf life, Failure modes observed, Product performance, Packaging Stabilizer, Estimation of reliability and life of the product, Effect of temperature and humidity on the life.	
5	**Certification and Standards** Certification organizations, Certification processes, Test standards, Practical's and experience sharing ISO 10964, ISO 10123, ISO 16047.	7
	Total	**39**

Adhesive Technology Laboratory (DJS23MLPE515)	
Sr. No.	**Experiment Title**
1	Joint strength of a lap joint subjected to tensile load.
2	Break-loose strength of various thread locking options and commonly accepted mechanical locking devices.
3	Threadlocker in a blind hole and through holes.
4	Mechanical locking device.
5	Large nuts and bolts.
6	Anaerobic technology for bonding.
7	Preventive maintenance and repairs using adhesives.
8	Thread sealant pressurized pipe.
9	Gasketing with adhesives.
10	Pre-cut gasket.
11	Pressurized flange sealing.

Books Recommended:

Textbooks:

- LOCTITE Handbook on "How to Increase Reliability and Prevent Threaded Assembly failure", ISBN: 9783941 517769.

Reference Books:

- E. M. Petrie, An Introduction to Adhesive and Sealants. In: Handbook of Adhesives and Sealants, McGraw-Hill Professional, New York, NY, USA; 1999.
- S. Ebnesajjad, Adhesive Technology Handbook, William Andrew Inc., Norwich, NY, USA; 2008.
- I. Skeist, and J. Miron, Introduction to Adhesives, Handbook of Adhesives, Boston, Springer; 1990.
- K. C. Kapur, and M. Pecht, Reliability Engineering, Wiley, 2014.

Web References:

- Methods of Adhesion Measurement for Pressure Sensitive Adhesives: Theory and Practice (https://nptel.ac.in/courses/103104569).

Program: Mechanical Engineering	T.Y. B.Tech	Semester: V
Course: Data Analytics (DJS23MCPE516)		
Course: Data Analytics Laboratory (DJS23MLPE516)		

Pre-requisites:

1. Fundamentals of Mechanical Engineering.
2. Engineering Mathematics and Statistics.
3. Basics of Probability and Statistics.

Objectives:

1. To explore the fundamental concept of data analytics and its relationship with AI-ML-DL.
2. To apply descriptive and inferential statistics to solve mechanical engineering problems.
3. To understand the various data analytics approaches and visualization techniques
4. To apply various machine learning techniques for data analysis.

Outcomes: On completion of the course, the learner will be able to:

1. Explain the fundamentals of data analytics and select a suitable approach for data analytics.
2. Apply descriptive analytics to describe and analyze the data.
3. Apply descriptive, diagnostic, predictive, and prescriptive analytics techniques to withdraw useful conclusions from the acquired data set.
4. Use inferential analytics to draw critical inferences from the given data.
5. Select suitable plots for the given data and draw practical interpretations.

Data Analytics (DJS23MCPE516)		
Unit	**Description**	**Duration**
1	**Introduction** Data science and data analytics, Types of data, Data collection and data generation methods, Data storing, Data pre-processing, Data describing/ visualization, Statistical modelling, Algorithmic modelling, Missing data treatment, Relationship between AI, ML, DL, and data science, Big data, and Database system.	6
2	**Descriptive Statistics** Universe, population, and sample, Measures of central tendency and their characteristics, outlier detection, histogram, and central tendency, measures of spread, variance, and percentiles, Effect of transformation of measure of spread.	7
3	**Inferential Statistics** Sampling distribution, Hypothesis testing, Types of errors, level of significance, p-test, Chi-Square test, z-test, t-test, ANOVA, K-S test, Correlation analysis, Maximum likelihood test, Taguchi analysis.	9
4	**Data Analytics Approaches** **Predictive analytics** – predictions using statistical modeling and machine learning techniques; demand forecasting; anomaly detection. **Prescriptive analytics –** process improvement decisions; supplier reviewing, maintenance scheduling. **Descriptive analytics –** trends and patterns in the data, data visualization tools. **Diagnostics analytics –** root cause analysis, data mining, correlation, product quality analysis.	8

5	**Data Visualization using Python/R/Tableau / Power BI** Histogram, Bar/ line chart, Box plots, swarm plot, Violin plot, faceted plot, boxen plot, leaf and stem plots, Scatter plots, Heat map, Bubble chart, pie chart, line plot.	9
	Total	**39**

Note: Numerical/ case studies should be solved/ presented related to mechanical and allied engineering domains. The following are some of the domains: Thermal/ Heat Transfer/ HVAC/ Fluid Mechanics/ Fluid Power, Solid Mechanics/ Design, Machining/ Manufacturing, Automation and Robotics, Maintenance/ reliability/ condition monitoring, Quality Control, Materials and metallurgy, Energy Conservation and Management, Industrial Engineering, Estimation, and Management, Automotive Technology.

Data Analytics Laboratory (DJS23MLPE516)	
Sr. No.	**Experiment Title**
Group A: Any five experiments from the following list should be performed for a data set using a suitable software package/ programming language.	
1	To study data science, data analytics, and AI-ML-DL.
2	To perform descriptive statistical analysis by using the data from the literature or mechanical laboratory. Data can be generated by performing bending tests on the paper clips. The minimum number of data points should be 30.
3	Development and performance evaluation of a linear regression model for predicting component failure time in mechanical systems.
4	Development and performance evaluation of a decision tree classification model for predicting failure risk level of mechanical components.
5	Hypothesis testing of mechanical system parameters using parametric and non-parametric statistical tests.
6	Optimization of Surface Roughness in Turning Operation Using Taguchi Method
7	To visualize a given data set (paperclip tests/ literature/ laboratory) - scattered diagram, Bar/ line chart, histogram, Box plots, and pie charts.
8	To visualize a given data set (paperclip tests/ literature/ laboratory) - swarm plot, Violin plot, faceted plot, boxen plot, leaf and stem plots, Heat map, Bubble chart, line plot.
9	To estimate the best-fit probability distribution for a given data set - Weibull, Exponential, Normal, and Lognormal.
Group B (Mandatory) One mini project (in a group of 2-3 students) based on the above contents and using the mechanical engineering application dataset.	

Books Recommended:

Textbooks:

- S. L. Brunton, and J. N. Kutz, Data-driven science and engineering: Machine learning, dynamical systems, and control, Cambridge University Press, 2022.
- P. F. Dunn, and M. P. Davis, Measurement and data analysis for engineering and science, CRC Press, 2017.
- S. S. Roy, P. Samui, R. Deo, and S. Ntalampiras, Big data in engineering applications (Vol. 44), Berlin/Heidelberg, Springer, Germany, 2018.
- J. A. Middleton, Experimental Statistics and Data Analysis for Mechanical and Aerospace Engineers, Chapman and Hall/CRC, 2021.

- E. L. Robinson, Data analysis for scientists and engineers. In Data Analysis for Scientists and Engineers, Princeton University Press, 2017.
- S. Araghinejad, Data-driven modeling: using MATLAB® in water resources and environmental engineering (Vol. 67), Springer Science & Business Media, 2013.
- G. Niu, Data-driven technology for engineering systems health management, Springer, Beijing, China, 2017.

Reference Books:

- Zsolt Nagy, Artificial Intelligence and Machine Learning Fundamentals, Packt Publishing, 2018.
- Hastie Trevor, Robert Tibshirani, Jerome H. Friedman, and Jerome H. Friedman. The elements of statistical learning: data mining, inference, and prediction. Vol. 2. New York: Springer, 2009.
- M. J. Zaki, M. Wagner, and Wagner Meira. Data mining and analysis: fundamental concepts and algorithms. Cambridge University Press, 2014.

Web References:

- Foundations of Data Science (https://padhai.onefourthlabs.in/courses/data-science)
- Data Analytics with Python (https://nptel.ac.in/courses/106107220)
- Introduction to Data Analytics (https://nptel.ac.in/courses/110106072)

Program: Mechanical Engineering	**T.Y. B.Tech.**	**Semester: V**
Course: Fundamentals of Business Development (DJS23MCPE517)		
Course: Fundamentals of Business Development Laboratory (DJS23MLPE517)		

Pre-requisite: Nil

Objectives:

1. Gain insights into essential concepts and principles for effective business development.
2. Develop the ability to think strategically, analyse markets, and create sound business strategies.
3. Learn methods to attract and retain customers, focusing on building lasting relationships.
4. Acquire proficiency in essential sales techniques, negotiation skills, and effective communication for successful business development.
5. Understand the importance of partnerships, learn collaboration strategies, and explore models for mutual benefit.

Outcomes: On completion of the course, the learner will be able to:

1. Demonstrate a comprehensive understanding of essential concepts and principles foundational to effective business development.
2. Apply strategic thinking, analyse market dynamics, and formulate robust business strategies to address diverse challenges.
3. Effectively employ methods for customer attraction and retention, emphasizing the establishment and nurturing of enduring customer relationships.
4. Showcase proficiency in essential sales techniques, negotiation skills, and articulate communication for successful business development.
5. Assess the importance of partnerships, implement effective collaboration strategies, and explore models fostering mutual benefit.

Fundamentals of Business Development (DJS23MCPE517)		
Unit	**Description**	**Duration**
1	**Strategic Business Planning** • Fundamentals of Strategic Planning • Case studies on failed ventures and reflections on personal setbacks • Market Trends and Competitive Analysis • Formulating Business Strategies • Value-Based Learning & SDG Alignment • Case Studies on Successful Business Planning	8
2	**Customer Acquisition and Retention** • Methods for Acquiring and Retaining Customers • Building and Maintaining Customer Relationships • Customer Loyalty Programs • Case Studies on Successful Customer Engagement	8
3	**Sales and Negotiation Skills** • Essential Sales Techniques • Negotiation Skills in Business Development • Effective Communication in Sales	8

	• Role-Playing Exercises on Sales and Negotiation	
4	**Partnership and Collaboration Strategies** • Importance of Partnerships in Business Development • Strategies for Building Successful Partnerships • Collaborative Business Models • Case Studies on Partnership Success and Failures • Proposal Development for Potential Partnerships	7
5	**Financial Modeling for Business Growth** • Principles of Financial Modelling • Key Financial Metrics for Decision-Making • Financial Analysis for Business Growth • Investment Scenarios and Decision-Making • Discussion on Financial Models • Innovative Approaches to Business Development • Adaptive Strategies for Changing Business Environments • Case Studies on Business Innovation • Innovative Business Plan Presentation • Course Review and Reflection	8
	Total	**39**

Fundamentals of Business Development Laboratory (DJS23MLPE517)		
Sr. No.	**Exercise**	**Detailed Description**
1	Strategic Business Plan Development	• Conduct market research and competitive analysis. • Formulate clear business objectives and strategies. • Identify potential challenges and propose mitigation strategies. • Create a detailed implementation plan.
2	Customer Journey Mapping	• Identify touchpoints in the customer journey. • Analyse customer interactions and experiences. • Develop strategies to enhance customer satisfaction and loyalty. • Create a visual representation of the customer journey.
3	Sales Pitch and Negotiation Simulation	• Develop a compelling sales pitch for a product or service. • Participate in simulated negotiation scenarios. • Receive constructive feedback from peers and instructors. • Refine sales and negotiation skills through practice.
4	Partnership Identification and Proposal	• Research potential partners in the industry. • Assess compatibility and alignment of goals. • Develop a partnership proposal highlighting collaborative opportunities. • Present the proposal effectively to a simulated audience.
5	Financial Modelling Project	• Create a detailed financial model using relevant metrics. • Analyse financial data to assess project viability. • Consider different investment scenarios and their impact. • Present findings and recommendations based on financial modelling.
6	Innovation Challenge	• Identify a real or simulated business innovation challenge. • Formulate innovative solutions through brainstorming and ideation.

		• Develop a detailed plan for implementing the proposed solutions. • Present the innovation challenge solution for evaluation.

Any other exercise/experiment based on syllabus may be included, which would help the learner to apply the concept learnt.

Books Recommended:

Textbook:

- Skripak, Stephen J. Fundamentals of Business. OpenStax, Virginia Tech Publishing, 2023.

Reference Books:

- F. R. David, Strategic Management: Concepts and Cases. Pearson Education, 17th Edition, 2017.
- J. Kaufman, The Personal MBA, Penguin Books, 2010.
- A. T. Lawrence, and J. Weber, Business and Society: Stakeholders, Ethics, Public Policy, McGraw-Hill Education, 15th Edition, 2016.
- W. M. Pride, R. J. Hughes, and J. R. Kapoor, Foundations of Business, Cengage Learning, 6th Edition, 2020.
- E. Ries, The Lean Startup, Crown Business, 2011.
- S. P. Robbins, T. A. Judge. Organizational Behavior. Pearson Education, 13th Edition, 2009.
- S. Ross, R. Westerfield, and J. Jaffe, Corporate Finance: Core Principles and Applications. McGraw-Hill Education, 5th Edition, 2019.
- P. Thiel, and M. Masters. Zero to One, Crown Business, 2014.
- D. Besanko, D. Dranove, M. Shanley, and S. Schaefer, Economics of Strategy, Wiley, 6th Edition, 2012.
- S. R. Covey, The 7 Habits of Highly Effective People. Free Press, 1989.

Program: Mechanical Engineering	**T.Y. B. Tech.**	**Semester: V**
Course: Environmental Studies (DJS23ITHSX10)		

Pre-requisite: Interest in the environment and its impact on humans.

Objectives:

1. Familiarise students with environmental-related issues, such as depleting resources, pollution, ecological problems, and the renewable energy scenario.
2. Give an overview of Green Technology options.

Outcomes: On completion of the course, the learner will be able to:

1. Understand how human activities affect the environment.
2. Understand the various technology options that can make a difference.

Environmental Studies (DJS23ITHSX10)		
Unit	**Description**	**Duration**
1	**Air Pollution** i. Air Quality Index ii. Case study on Smog	1
2	**Water Pollution** Presentation on Water Pollution (Industrial, Sewage, etc.) explaining any specific case	1
3	**Noise Pollution** i. Decibel limits for hospital, library, silence zone ii. List effects of noise pollution on human health iii. Measure decibel level in college library, canteen, classroom	1
4	**Biodiversity loss** Case study on effect of pollution on biodiversity loss	1
5	**Deforestation** Debate for and against "To promote Economic growth Deforestation is required"	1
6	**Renewable Energy sources** Presentation on different Renewable Energy Technologies	1
7	**Climate change** Report on major Impact of Global warming on Environment giving real examples**.**	1
8	**Green Technology** Advantages and Examples of Green Building for Sustainable development, Sustainable Software Design, Data Center Energy Efficiency, Thin-Client and Energy Efficiency.	1

Books Recommended:

Text books:

- R. Rajagopalan, Environmental Studies: From Crisis to Cure, Oxford University Press, 2011.
- Erach Bharucha, Textbook of Environmental Studies For Undergraduate Courses, Universities Press (India) Pvt. Limited, 2005.
- Mohammad Dastbaz, Colin Pattinson, Babak Akhgar, Morgan and Kaufman, Green Information Technology A Sustainable Approach, Elsevier, 2015.

Reference Books:

- Paulina Golinska, Marek Fortsch, Jorge Marx-Gómez, Information Technologies in Environmental Engineering: New Trends and Challenges, Springer, 2011.

Program: Mechanical Engineering	T.Y. B. Tech	Semester: V
Course: Innovative Product Development III (DJS23IPSCX03)		

Objectives:

1. To acquaint the students with the process of identifying the need (considering a societal requirement) and ensuring that a solution is found out to address the same by designing and developing an innovative product.
2. To familiarize the students with the process of designing and developing a product, while they work as part of a team.
3. To acquaint the students with the process of applying basic engineering fundamentals, so as to attempt at the design and development of a successful value-added product.
4. To inculcate the basic concepts of entrepreneurship and the process of self-learning and research required to conceptualize and create a successful product.

Outcomes: On completion of the course, the learner will be able to:

1. Identify the requirement for a product based on societal/research needs.
2. Apply knowledge and skills required to solve a societal need by conceptualizing a product, especially while working in a team.
3. Use standard norms of engineering concepts/practices in the design and development of an innovative product.
4. Draw proper inferences through theoretical/ experimental/simulations and analyze the impact of the proposed design and development of the product.
5. Develop product/project management skills, interpersonal skills, self-learning and effective communication eventually preparing them to be successful entrepreneurs.

Guidelines for the proposed product design and development:

- Students shall form a team of 3 to 4 students (max allowed: 5-6 in extraordinary cases, subject to the approval of the department review committee and the Head of the department).
- Students should carry out a survey and identify the need, which shall be converted into conceptualization of a product, in consultation with the faculty supervisor/head of department/internal committee of faculty members.
- Students should recognize the essential requirements for product development and choose the most suitable design in consultation with the faculty supervisor.
- Students shall transform the most appropriate design solution into a functional model, incorporating components from their specific domain and related interdisciplinary fields.
- Throughout the two-semester duration of the activity, faculty supervisors will provide guidance to students, with a primary emphasis on self-directed learning.
- Each team is required to maintain an activity log-book, where they can document their weekly progress. The guide or supervisor should review the recorded notes and comments and provide approval on a weekly basis.
- Students should validate the design solution with appropriate justifications and compile a report in a standard format for submission to the department. Additionally, students are encouraged to make efforts to publish a technical paper, either in the institute journal 'Techno Focus: Journal for Budding Engineers' or in a suitable publication approved by the department's research committee or the Head of the department.
- The focus should be on self-learning, capability to design and innovate new products as well as on developing the ability to address societal problems. Advancement of entrepreneurial

capabilities and quality development of the students through the year long course should ensure that the design and development of a product of appropriate level and quality is carried out, spread over two semesters, i.e. during the semesters III and IV.

Guidelines for Assessment of the work:

- The review/ progress monitoring committee shall be constituted by the Head of the Department. The progress of design and development of the product is to be evaluated on a continuous basis, holding a minimum of two reviews in each semester.
- In the continuous assessment, focus shall also be on each individual student's contribution to the team activity, their understanding and involvement as well as responses to the questions being raised at all points in time.
- Distribution of marks individually for the both reviews as well as for the first review during the subsequent semester shall be as given below:
    - Marks awarded by the supervisor based on log-book: 20
    - Marks awarded by review committee: 20
    - Quality of the write-up: 10

In the last review of the semester VI, the term work marks will be awarded as follows.

A. Marks awarded by the supervisor (Considering technical paper writing): 15

B. Marks awarded by the review committee: 10

Review/progress monitoring committee may consider the following points during the assessment.

- In semester V, the entire design proposal shall be ready, including components/system selection as well as the cost analysis. Two reviews will be conducted based on the presentation given by the student's team.
    - ▪ First shall be for finalization of the product selected.
    - ▪ Second shall be on finalization of the proposed design of the product.
- In the semester VI, the expected work shall be procurement of components/systems, building of the working prototype, testing and validation of the results based on work completed in semester V.
    - ▪ First review is based on readiness of building the working prototype.
    - ▪ Second review shall be based on a presentation as well as the demonstration of the working model, during the last month of semester VI. This review will also look at the readiness of the proposed technical paper presentation of the team.

The overall work done by the team shall be assessed based on the following criteria;

1. Quality of survey/ need identification of the product.
2. Clarity of Problem definition (design and development) based on need.
3. Innovativeness in the proposed design.
4. Feasibility of the proposed design and selection of the best solution.
5. Cost effectiveness of the product.
6. Societal impact of the product.
7. Functioning of the working model as per stated requirements.
8. Effective use of standard engineering norms.
9. Contribution of each individual as a member or the team leader.
10. Clarity on the write-up and the technical paper prepared.

• The semester reviews (V and VI) may be based on relevant points listed above, as applicable.

Guidelines for Assessment of Semester Reviews:

- The write-up should be prepared as per the guidelines given by the department.
- The evaluation of the product's design and development will involve a presentation and demonstration of the working model by the student team. This assessment will be conducted before a panel of Internal and External Examiners, preferably with more than five years of experience in industry or research organizations. The Head of the Institution approves the selection of these examiners. The presence of an external examiner is desirable only for the second presentation during semester VI. Additionally, students are required to present an outline of the technical paper they have prepared during the final review in semester VI.

Prepared by Checked by Head of the Department Principal