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)

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 (DJS22)

Third Year B. Tech

In

Mechanical Engineering

(Semester V & VI)

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-DJS22)

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	DJS22MEC501	Automotive Prime Movers	3	--	--	3	35	--	35	65	--	--	--	65	100	3	**4**
	DJS22MEL501	Automotive Prime Movers Laboratory	--	2	--	1	--	25	25	--	--	--	--	--	25	1	
2	DJS22MEC502	Heat Transfer	3	--	--	3	35	--	35	65	--	--	--	65	100	3	**4**
	DJS22MEL502	Heat Transfer Laboratory	--	2	--	1	--	25	25	--	--	--	--	--	25	1	
3	DJS22MEC503	Dynamics of Machinery	3	--	--	3	35	--	35	65	--	--	--	65	100	3	**4**
	DJS22MEL503	Dynamics of Machinery Laboratory	--	2	--	1	--	25	25	--	--	--	--	--	25	1	
4	DJS22MEC504	Industrial Electronics	3	--	--	3	35	--	35	65	--	--	--	65	100	3	**4**
	DJS22MEL504	Industrial Electronics Laboratory	--	2	--	1	--	25	25	--	--	--	--	--	25	1	
5	DJS22MEL505	Database Management Systems Laboratory	--	2	--	1	--	25	25	--	--	--	25	25	50	1	**1**
6 @	DJS22MEC5011	Advance Materials and Processes	3	--	--	3	35	--	35	65	--	--	--	65	100	3	**4**
	DJS22MEL5011	Advance Materials and Processes Laboratory	--	2	--	1	--	25	25	--	--	--	--	--	25	1	
	DJS22MEC5012	Automobile Engineering	3	--	--	3	35	--	35	65	--	--	--	65	100	3	
	DJS22MEL5012	Automobile Engineering Laboratory	--	2	--	1	--	25	25	--	--	--	--	--	25	1	
	DJS22MEC5013	Reliability Engineering	3	--	--	3	35	--	35	65	--	--	--	65	100	3	
	DJS22MEL5013	Reliability Engineering Laboratory	--	2	--	1	--	25	25	--	--	--	--	--	25	1	
	DJS22MEC5014	Power Engineering	3	--	--	3	35	--	35	65	--	--	--	65	100	3	
	DJS22MEL5014	Power Engineering Laboratory	--	2	--	1	--	25	25	--	--	--	--	--	25	1	
	DJS22MEC5015	Data Analytics	3	--	--	3	35	--	35	65	--	--	--	65	100	3	
	DJS22MEL5015	Data Analytics Laboratory	--	2	--	1	--	25	25	--	--	--	--	--	25	1	
	DJS22MEC5016	Incubation, Entrepreneurship and Start-ups	3	--	--	3	35	--	35	65	--	--	--	65	100	3	
	DJS22MEL5016	Incubation, Entrepreneurship and Start-ups Laboratory	--	2	--	1	--	25	25	--	--	--	--	--	25	1	
	DJS22MEC5017	Design Validation through Prototyping	3	--	--	3	35	--	35	65	--	--	--	65	100	3	
	DJS22MEL5017	Design Validation through Prototyping Laboratory	--	2	--	1	--	25	25	--	--	--	--	--	25	1	
7	DJS22A3	Environmental Studies	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--
8	DJS22ILLL1	Innovative Product Development III	--	2	--	1	--	25	25	--	--	--	25	25	50	1	**1**
		Total	**16**	**14**	**0**	**22**	**175**	**175**	**350**	**325**	**0**	**0**	**50**	**375**	**725**	**22**	

@Any 1 Department Elective from given list.

Prepared by Checked by Head of the Department Principal

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Scheme for Third Year of B.Tech. Program in Mechanical Engineering: Semester VI
(Autonomous-DJS22)

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	DJS22MEC601	Design of Machine Elements	3	--	--	3	35	--	35	65	--	--	--	65	100	3	**4**
	DJS22MEL601	Design of Machine Elements Laboratory	--	2	--	1	--	25	25	--	--	--	--	--	25	1	
2	DJS22MEC602	Finite Element Analysis	3	--	--	3	35	--	35	65	--	--	--	65	100	3	**4**
	DJS22MEL602	Finite Element Analysis Laboratory	--	2	--	1	--	25	25	--	--	--	--	--	25	1	
3	DJS22MEC603	Control Systems	3	--	--	3	35	--	35	65	--	--	--	65	100	3	**4**
	DJS22MEL603	Control Systems Laboratory	--	2	--	1	--	25	25	--	--	--	--	--	25	1	
4 @	DJS22MEC6011	Quality Engineering	3	--	--	3	35	--	35	65	--	--	--	65	100	3	**4**
	DJS22MEL6011	Quality Engineering Laboratory	--	2	--	1	--	25	25	--	--	--	--	--	25	1	
	DJS22MEC6012	Vehicle Dynamics and NVH	3	--	--	3	35	--	35	65	--	--	--	65	100	3	
	DJS22MEL6012	Vehicle Dynamics and NVH Laboratory	--	2	--	1	--	25	25	--	--	--	--	--	25	1	
	DJS22MEC6013	Mechanical Vibrations	3	--	--	3	35	--	35	65	--	--	--	65	100	3	
	DJS22MEL6013	Mechanical Vibrations Laboratory	--	2	--	1	--	25	25	--	--	--	--	--	25	1	
	DJS22MEC6014	Refrigeration and Air-conditioning	3	--	--	3	35	--	35	65	--	--	--	65	100	3	
	DJS22MEL6014	Refrigeration and Air-conditioning Laboratory	--	2	--	1	--	25	25	--	--	--	--	--	25	1	
	DJS22MEC6015	Machine Learning	3	--	--	3	35	--	35	65	--	--	--	65	100	3	
	DJS22MEL6015	Machine Learning Laboratory	--	2	--	1	--	25	25	--	--	--	--	--	25	1	
	DJS22MEC6016	Fundamentals of Business Development	3	--	--	3	35	--	35	65	--	--	--	65	100	3	
	DJS22MEL6016	Fundamentals of Business Development Laboratory	--	2	--	1	--	25	25	--	--	--	--	--	25	1	
	DJS22MEC6017	Creative Engineering Design	3	--	--	3	35	--	35	65	--	--	--	65	100	3	
	DJS22MEL6017	Creative Engineering Design Laboratory	--	2	--	1	--	25	25	--	--	--	--	--	25	1	
	DJS22MEC6018	Mechatronics	3	--	--	3	35	--	35	65	--	--	--	65	100	3	
	DJS22MEL6018	Mechatronics Laboratory	--	2	--	1	--	25	25	--	--	--	--	--	25	1	
5 #	DJS22IHL	Professional and Business Communication Laboratory	--	4	--	2	--	50	50	--	--	--	--	--	50	2	**2**
6	DJS22MEL604	CAD CAM Laboratory	--	2	--	1	--	25	25	--	--	--	25	25	50	1	**1**
7	DJS22ILLL2	Innovative Product Development IV	--	2	--	1	--	25	25	--	25	--	--	25	50	1	**1**
		Total	**12**	**16**	**0**	**20**	**140**	**200**	**340**	**260**	**25**	**0**	**25**	**310**	**650**	**20**	

@Any 1 Department Elective from given list. # 2 hrs. of theory (class wise) and 2 hrs of activity based laboratory (batch wise)

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)	20	60
	b. Term test 2 (next 40 % syllabus)	15	60
	Total Marks (a + b)	35	--
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 and 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.	65	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 and 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: Automotive Prime Movers (DJS22MEC501)		
Course: Automotive Prime Movers Laboratory (DJS22MEL501)		

Pre-requisite: --

1. Thermodynamics

Objectives:

1. To study the components of an internal combustion engine and its systems.
2. To familiarise with different systems in SI & CI engines.
3. To analyse 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. Explain the construction and working of internal combustion engines.
2. Demonstrate the working systems of spark ignition & compression ignition engines.
3. Demonstrate the engine cooling, lubrication and super-charging systems.
4. Analyze various engine performance parameters.
5. Describe the different hybrid and electric powertrain systems.

Automotive Prime Movers (DJS22MEC501)		
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 working cycle, Valve timing diagram. **Spark Ignition (SI) Engines** **Fuel supply system:** Air-Fuel mixture requirements for steady state and transient operations. **Fuel Injection systems:** Single-point and Multipoint injection systems, Gasoline Direct Injection. Engine Control Unit (ECU), Important sensors & actuators, Open loop and closed loop modes of operation. **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.	**07**
2	**Compression Ignition (CI) Engines** **Fuel Injection Systems:** Fuel injection systems, Common rail, individual pump, distributor and unit systems, Types of nozzle, fuel atomization and spray structures, Electronically controlled unit fuel injection system. Load and speed control of CI engines. **Combustion:** Combustion phenomenon in C I engines, Stages of combustion, Delay period, Knocking, Pressure-Crank angle diagram, Factors affecting combustion and knocking, Types of combustion chambers.	**07**

3	**Engine cooling systems**: Necessity of engine cooling, Cooling systems and their comparison: Air cooling, Liquid cooling, Troubleshooting & maintenance. **Engine lubrication systems:** Types of lubricants and their properties, SAE rating of lubricants, Types of lubrication systems and their applications. **Supercharging/Turbo-charging:** Objectives and limitations, Methods, types and different arrangements of superchargers and turbochargers.	**06**
4	**Engine Performance & 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. Emission control systems, Bharat Stage VI emission norms. **Alternative fuels:** Ethanol, Bio-diesel, CNG, LPG, Hydrogen - Merits, demerits and engine modifications. **Recent developments:** Camless engine, Variable valve timing, Stratification in GDI engines, LHR engine, HCCI engine & six stroke engine	**09**
5	**Hybrid powertrain:** Hybrid Powertrain Architecture, Hybrid Powertrain Performance - Series architecture and Parallel architecture, Hybrid Power System Components, Degree of hybridization Regenerative Breaking, Hybrid Power System Components – Battery, Hybrid Powertrain Energy Management	**05**
6	**Electric powertrain:** Introduction to electric components used in hybrid and electric vehicles, Configuration and control of DC Motor drives, Configuration and control of Induction Motor drives, Configuration and control of Permanent Magnet Motor drives, Configuration and control of Switch Reluctance Motor drives, drive system efficiency.	**05**
	Total	**39**

Automotive Prime Movers Laboratory (DJS22MEL501)	
Exp.	**Suggested experiments**
1	Study of components of an internal combustion engine
2	Estimation of valve timing for four SI / CI Engine.
3	Study of ignition system of SI engines.
4	Study of fuel injection system in CI engines
5	Analysis of supercharging and turbo charging of I C engines.
6	Load Test on CI engine.
7	Speed Test on SI engine.
8	Heat Balance test on SI or CI engines
9	Experimental determination of friction power of multi-cylinder SI engine using Morse test method.
10	Experimental determination of Air fuel ratio and volumetric efficiency of the engine.
11	Simulation of electric/hybrid powertrain on MATLAB Simulink software.
12	Study of electric motor test methods.

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:

Text books:

1. V Ganesan, 'Internal Combustion Engine', 4th Edition, 2017, McGraw Hill
2. Mathur and Sharma, 'Internal Combustion Engine', 2014, Dhanpat Rai Publications
3. H. N. Gupta, 'Internal Combustion Engines', 2nd Edition, 2012, PHI
4. R K Rajput, 'Internal Combustion Engines', 3rd Edition, 2016, Laxmi Publications
5. Tom Denton, 'Automotive Electrical and Electronic Systems', 5th Edition, 2017, Routledge

Reference books:

1. Tom Denton, 'Automotive Electrical and Electronic Systems', 5th Edition, 2017, Routledge
2. Colin Ferguson and Allan Kirkpatrick, 'Internal Combustion Engines' , 2nd Edition, Wiley India Pvt. Ltd
3. Willard W. Pulkrabek, 'Internal Combustion Engines', 2nd Edition, 2013, Pearson Education.
4. Richard Stone, 'Introduction to Internal Combustion Engines', 4th Edition, 2012, Palgrave Publication.
5. Mehrdad, Yimin, Sebastian, Ali, 'Modern Electric, Hybrid Electric, and Fuel Cell Vehicles', 3rd Edition, CRC Press

Program: Mechanical Engineering	T.Y. B. Tech	Semester: V
Course: Heat Transfer (DJS22MEC502)		
Course: Heat Transfer Laboratory (DJS22MEL502)		

Pre-requisite: Knowledge of

1. Engineering Mathematics
2. Engineering Thermodynamics
3. Fluid Mechanics

Objectives:

1. To introduce the basic principles of heat transfer and steady state conduction.
2. To determine heat transfer from extended surfaces and unsteady state conduction.
3. To familiarize the principles of convection and the significance of dimensionless numbers.
4. To introduce different types of heat exchangers and their analysis.
5. To describe the principles of radiation heat transfer.
6. To practice computational techniques used in heat transfer and their applications.

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

1. Apply the principles of heat transfer to solve problems related to steady state conduction.
2. Analyse and solve problems involving heat transfer from extended surfaces and unsteady state conduction.
3. Apply the principles of convection to solve heat transfer problems.
4. Design and analyse heat exchangers for various applications.
5. Apply the principles of radiation to solve heat transfer problems.
6. Apply various numerical methods to solve heat transfer problems.

Heat Transfer (DJS22MEC502)		
Unit	**Description**	**Duration**
1	**Introduction:** Thermodynamics and Heat Transfer, Applications of Heat Transfer, Basic Modes of Heat Transfer, Physical Mechanism of Heat Transfer, Fourier's Law of Heat Conduction, Newton's Law of Cooling, Stefan-Boltzmann Law. **One-Dimensional Steady State Conduction:** Thermal Conductivity, Variation of Thermal Conductivity in Solids, Liquids, and Gases, Thermal Diffusivity, General Heat Conduction Equation, Electrical Network Analogy, Boundary and Initial Conditions, Steady State Heat Conduction in Walls, Cylinders, and Spheres, Thermal Contact Resistance, Critical Thickness of Insulation.	**07**
2	**Heat transfer from Extended Surface:** Types of fins and their applications, Heat transfer from finned surface of uniform cross sectional area, Effectiveness and Efficiency of fins, proper length of a fin. **Unsteady state Conduction:** Lumped Capacitance method, Biot number, Fourier number and their significance, Heisler charts.	**06**
3	**Convection:** Natural and Forced Convection, Hydrodynamic and Thermal Boundary Layers, Heat Transfer Coefficient, Principle of Dimensional Analysis, Buckingham's π Theorem, Application of Buckingham's π Theorem to Forced and Natural Convection, Physical Significance of Dimensionless Numbers, Nusselt Number, Grashof Number, Prandtl Number,	**06**

	Reynolds Number, and Stanton Number, Empirical Relations for Free and Forced Convection for Standard Cases.	
4	**Heat Exchangers:** Types of Heat Exchangers, Overall Heat Transfer Coefficient, Fouling Factor, Heat Exchanger Analysis using Log Mean Temperature Difference and Effectiveness-NTU method, Selection of heat exchangers, compact heat exchangers. **Boiling and Condensation:** Boiling heat transfer, Pool boiling, Boiling Regimes and Boiling Curve, Flow boiling, Condensation heat transfer, Film condensation, Dropwise Condensation.	**07**
5	**Radiation:** Emissive power, Emissivity, Irradiation, Radiosity, Absorptivity, Reflectivity and Transmissivity, Black body, Grey body, Opaque body, Kirchhoff's law, Planck's law, Wein's displacement law, Lambert cosine law, Intensity of Radiation, Solid Angle, Radiation heat exchange between two black and gray surfaces, View factor, View Factor relations, Application of Electrical Analogy to thermal radiation heat exchange between two parallel infinite plates, concentric infinitely long cylinders and two concentric spheres, Radiation shields.	**07**
6*	**Computational Techniques in Heat Transfer:** (NOT INCLUDED IN ESE) Overview of computational techniques in heat transfer, importance and applications, Numerical Methods in Heat Transfer: Finite Difference Method, Finite Element Method, and Finite Volume Method, Central, Forward, and Backward difference expressions for a uniform grid, Numerical errors, Finite difference solution for a one-dimensional steady state problem using Gaussian elimination and Gauss-Seidel iterative methods, Finite difference solution for transient one-dimensional problems: Euler, Crank-Nicolson, and pure implicit methods, accuracy, stability of transient heat transfer problems.	**06**
	Total	**39**

* This module is not included in the End Semester Examination. Instead, students are required to submit two assignments. The first assignment involves modeling a steady state heat transfer problem, while the second one involves an unsteady state heat transfer problem. Students must validate their results with analytical calculations. These assignments will serve as a practical evaluation of the students' ability to apply computational techniques in heat transfer problems.

Computational Heat Transfer Laboratory (DJS22MEL502)	
Exp.	**Suggested experiments**
1	Thermal conductivity of solid/liquid
2	Heat transfer coefficient in natural convection heat transfer
3	Heat transfer coefficient in forced convection heat transfer
4	Unsteady state heat transfer in cylinder/rod/wall
5	Fin efficiency and fin effectiveness
6	Critical heat flux
7	Overall heat transfer coefficient and effectiveness of heat exchanger
8	Stefan-Boltzmann apparatus
9	Emissivity of Grey surface
10	Numerical modelling of any heat transfer problem using FDM

Minimum seven 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:

Text books:

1. Yunus Cengel and Afshin Ghajar, 'Heat and Mass Transfer: Fundamentals and Applications', 6th Edition, McGraw Hill, 2020.
2. P. S. Ghoshdastidar, 'Heat Transfer', Second Edition, Oxford University Press, 2012.
3. R.K. Rajput, 'A Textbook of Heat and Mass Transfer (SI Units)', S. Chand, 2018.

Reference Books:

1. Theodore L. Bergman, Adrienne S. Lavine, Frank P. Incropera, David P. DeWitt, 'Fundamentals of Heat and Mass Transfer', 8th Edition, Wiley, 2018.
2. S.P. Sukhatme, 'Textbook of Heat Transfer', Fouth Edition, Universities Press, 2005.
3. C.P. Kothandaraman, 'Fundamentals of Heat and Mass Transfer', 4th Edition, New Age International Press, 2012,
4. Dr. D.S. Kumar, S.K. Kataria, 'Basics of Heat and Mass Transfer', 2018.

Program: Mechanical Engineering	T.Y. B.Tech	Semester: V
Course: Dynamics of Machinery (DJS22MEC503)		
Course: Dynamics of Machinery Laboratory (DJS22MEL503)		

Pre-requisite: --

1. Engineering Mechanics
2. Strength of Materials
3. Kinematics of Machinery

Objectives:

1. To acquaint with working principles and applications of Gyroscope
2. To study static and dynamic force analysis in mechanisms
3. To familiarize with basics of mechanical vibrations
4. To study the balancing of mechanical systems

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

1. Analyse the effect of gyroscopic couple on various applications
2. Analyse forces and torques that act on mechanisms
3. Determine vibration response of free undamped systems
4. Determine vibration response of free damped systems
5. Determine vibration response of systems subjected to forced vibrations
6. Apply the principles of force and couple balancing to solve engineering problems

Dynamics of Machinery (DJS22MEC503)		
Unit	**Description**	**Duration**
1	**Static and Dynamic Force Analysis:** Analysis of slider crank mechanism (neglecting mass of connecting rod and crank), Turning moment on crank shaft, fluctuation of energy, flywheel analysis - fluctuation of speed, energy stored, dimensions of flywheel rims, dynamically equivalent systems to convert rigid body into two masses with and without correction couple	**06**
2	**Gyroscope:** Gyroscopic couple and its effect on spinning bodies, naval ships during steering, pitching, rolling and their stabilization, Effect of gyroscopic and centrifugal couples on vehicles moving along a curved path, permissible speeds on curved paths	**05**
3	**Rotor Dynamics and Balancing:** Unbalance in machines, Critical speed of shaft with single rotor, Static and dynamic balancing of multi rotor system (up to four rotors), Balancing of reciprocating masses in In-line engines (up to four cylinders), Balancing machines	**06**
4	**4.1 Basic Concepts of Vibration:** Vibration and oscillation, causes and effects of vibrations, Vibration parameters - springs, mass, damper, Motion- periodic, non-periodic, degree of freedom, static equilibrium position, vibration classification, steps involved in vibration analysis **4.2 Free Undamped Single Degree of Freedom Vibration System:** Longitudinal, transverse, torsional vibration system, Methods for formulation of differential equations by Newton, Energy, Lagrangian and Rayleigh's method	**07**

5	**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	**07**
6	**6.1 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) **6.2 Vibration Isolation and Transmissibility:** Force Transmissibility and isolation, Typical isolators & mounts **6.3 Vibration Measuring Instruments:** Principle of seismic instruments, Vibrometer, Accelerometer - undamped and damped, Case studies on diagnostics maintenance and condition-based monitoring approach	**08**
	Total	**39**

Dynamics of Machinery Laboratory (DJS22MEL503)	
Exp.	**Suggested experiments**
1	Experiments on Governors- Porter Governor, Hartnell Governor
2	Experimental verification of principle of Gyroscopic couple
3	Determine natural frequency of compound pendulum, equivalent simple pendulum system
4	Determine natural frequency for longitudinal vibrations of helical springs
5	Determine natural frequency and nodal points for single rotor and two-rotor vibratory system
6	Experiment on whirling of shaft
7	Determination of damping coefficient of any system/media
8	Experimental balancing of single and multi-rotor system
9	Measurement of vibration response of a system
10	Condition monitoring using FFT analyzer
11	Vibration analysis of mechanical system using MATLAB/SCILAB/Python

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. Mini project/Assignments relevant to the subject may be included, which would help the learner to apply the concept learnt.

Books Recommended:

Text books:

1. S. S. Ratan, Theory of Machines, Tata McGraw Hill
2. J. K. Gupta and R. S. Khurmi, Theory of Machines, S. Chand Publishing

Reference Books:

1. Thomas Bevan, Theory of Machines, CSB Publishers & Distributors
2. Jagdishlal, Theory of Machines, Metropolitan Book New Delhi
3. P. L. Bellaney, Theory of Machines, Khanna publication
4. John J. Uicker, Gordon R. Pennock and Joseph E. Shigley, Theory of Machines and Mechanisms, Oxford University Press
5. W. Thomson, Theory of Vibration with Applications, Pearson Education

6. S. S. Rao, Mechanical Vibrations, Pearson Education
7. S. Graham Kelly, Fundamentals of Mechanical Vibration, Tata McGraw Hill
8. Principles of Vibration by Benson H Tongue, 2nd Edition, Oxford University Press
9. William W. Seto, Mechanical Vibrations- Schaum's outline series, McGraw Hill
10. J. S. Rao and K. Gupta, Theory and Practice of Mechanical Vibrations, New Age International

Program: Mechanical Engineering	T.Y. B.Tech	Semester: V
Course: Industrial Electronics (DJS22MEC504)		
Course: Industrial Electronics Laboratory (DJS22MEL504)		

Pre-requisite: --

1. Knowledge of basic electronic devices like Semiconductor Diodes

Objectives:

1. To study power electronic switches and circuits and their applications.
2. To familiarize Op-amp and digital circuits and their applications.
3. To acquaint with the basics of microcontrollers.
4. To study the working of Sensors and Motors.

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

1. Illustrate construction, working principles and applications of power electronic switches.
2. Identify rectifiers and inverters for DC and AC motor speed control.
3. Identify digital circuits for industrial applications.
4. Develop circuits using OPAMP and timer IC555.
5. Analyze and suggest application-specific sensors and motors.

Industrial Electronics (DJS22MEC504)		
Unit	**Description**	**Duration**
1	**Semiconductor Devices:** Review of diodes, V-I characteristics and Applications of: rectifier diode, zener diode, LED, photodiode; SCR V-I characteristics, UJT triggering circuit, turning-off of a SCR (preliminary discussion), basics of Gate Turn Off (GTO), Structure and V-I characteristics of Triac (modes of operation not needed) and Diac, Applications of Triac-Diac circuit; Characteristics of Power BJT, power MOSFET, IGBT; Comparison of SCR, Triac, Power BJT, power MOSFET, IGBT	**08**
2	**Phase-controlled rectifiers and Bridge inverters:** Half and Full wave controlled rectifiers using SCRs with R load only, H-Bridge for DC Motor, Block diagram of closed-loop speed control of DC motors, Basic principle of single phase and three phase bridge inverters, block diagrams including rectifier and inverter for speed control of AC motors (frequency control only)	**08**
3	**Element of Signal Conditioning:** Amplifiers, Attenuators, Filter Circuits Operational amplifier: Ideal and Practical OPAMP Characteristics, Basic OPAMP circuits- Inverting amplifier, Non-inverting amplifier, Voltage follower (Buffer), Comparator, Instrumentation Amplifier, Active filters; Power Op Amps, IC-555 timer-Operating modes: monostable, astable multivibrator	**08**
4	**Digital logic and Microcontrollers:** Boolean algebra and logic gates. TTL and CMOS logic families, Multiplexer and Demultiplexer applications, Flip flops: Set Reset(SR), Trigger(T), clocked F/Fs;	**08**

	Overview of generic microprocessor and Microcontrollers, Comparison of microprocessor and microcontroller, Features of Microcontroller General purpose i/o toggle and it's applications, Interrupts and ISR, Analog to digital converter, Serial communications - UART, SPI and I2C, Timer module, precise delay generation, timer waveforms, counting applications, Interrupt and polling mode of control. basics of interfacing with external input/output devices (like reading external analog voltages, digital input-output) Applications of the microcontroller: Temperature measurement, Speed Measurement, Solenoid, Relay, Motor Control, etc.	
5	**Sensors and Motors:** **Industrial Sensors:** Displacement, temperature, acceleration, force/pressure and optical sensors, static and dynamic characteristics. **Motors :** Review and comparison of DC motors and AC induction motors, Basic principles of speed control of DC motor, microcontroller-based speed control for DC Motor. Basic principles of speed control of AC induction motor, Basics of BLDC motor, Linear Actuators, Servo Motor; Motor Specifications, suitability of each motor for various industrial applications, Selection and sizing of motors for different applications. Applications for pumps, conveyors, machine tools	**07**
	Total	**39**

Industrial Electronics Laboratory (DJS22MEL504)	
Exp.	**Suggested experiments**
1	Study on MOSFET / IGBT as a switch
2	Study on Single phase Bridge inverter with rectifier load
3	Study on OPAMP as integrator
4	Implementing study of gates and Logic Operations like, NOT, AND, OR
5	Realization of basic gates using universal gates
6	Light dimmer circuit using Diac-Triac
7	Speed control of DC motor
8	Simple microcontroller-based applications like Temp Measurement/ Speed Measurement using Proximity
9	Speed control of induction motor
10	Speed control of 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:

1. Power Electronics M.H. Rashid, Prentice-Hall of India
2. Power Electronics, P S Bhimbra
3. Power Electronics, Vedam Subramanyam, New Age International
4. Power Electronics, Ned Mohan, Undeland, Robbins, John Wiley Publication
5. Electronic Devices and Circuits, Robert Boylestad and Louis Nashelsky, Prentice-Hall

6. Industrial Electronics and Control by S K Bhattacharya, S Chatterjee, TTTI Chandigarh
7. Modern Digitals Electronic, Jain R P, Tata McGraw Hill 8. Digital principal and Application, Malvino and Leach, Tata McGraw Hill
8. Fundamentals of Microcontrollers and Embedded System, Ramesh Gaonkar, PENRAM 10. MSP430
9. Microcontroller Basics, John H. Davies, Newnes
10. Modem Control engineering: by KOgata, Prentice Hall
11. Control systems by Dhanes Manik, Cengage Learning
12. Engineering Metrology and Measurements by N V Raghavendra and L Krishnamurthy, Oxford University Press
13. Instrumentation and Control System, W. Bolton, Elsevier

Program: Mechanical Engineering	**T.Y. B.Tech**	**Semester: V**
Course: Database Management System Laboratory (DJS22MEL505)		

Pre-requisite: --

1. Computer Basics

Objectives:

1. The course intends to introduce the students to the management of database systems, with an emphasis on 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 (DJS22MEL505)		
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	**10**
4	**Relational–Database Design:** Pitfalls in Relational-Database designs, Concept of normalization, Function Dependencies, Normal Forms- 1NF, 2NF, 3NF, BCNF	**04**
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	**04**
	Total	**26**

Database Management System Laboratory (DJS22MEL505)	
Exp.	**Suggested experiments**
1	To draw an ER diagram for a problem statement and map the ER diagram to relations.
2	To implement DDL and DML queries
3	Write queries using aggregate functions
4	Write queries using Joins
5	Write queries using sub-queries
6	To implement Integrity Constraints
7	To implement triggers.
8	To Study and Implement TCL Commands
9	Examine the consistency of database using concurrency control technique (Locks)
10	Case Study for a specific product/process a) Schema Design b) Database instance on cloud Build visualizations using SQL Queries.

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:

Text books:

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

Reference Books:

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

Prepared by Checked by Head of the Department Principal

Program: Mechanical Engineering	T.Y. B.Tech	Semester: V
Course: Advanced Materials and Processes (DJS22MEC5011)		
Course: Advanced Materials and Processes Laboratory (DJS22MEL5011)		

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 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. Understand the stimuli-response behavior of various smart materials along with their properties and processing.
2. Select an appropriate smart material and analyze it for applications such as sensors, actuators, self-healing and health monitoring of structures.
3. Understand the behavior of material at elevated temperature and select an appropriate material for high temperature applications.
4. Correlate structure, properties and synthesis of nanostructured materials & biomaterials and appreciate their engineering importance.
5. Demonstrate various materials and methods for energy storage and harvesting.

Advanced Materials & Processes (DJS22MEEC5011)		
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.	08
2	**Smart Materials – Part II** Brief overview, Related materials – composition, properties & processing, Effects, Constituting or governing equations and Industrial applications associated with following smart materials. Magnetorheological & Electrorheological fluids Magnetostrictive & Electrostrictive materials Electroactive polymers (EAP's): IPMC's, Dielectric polymers, Conductive polymers etc.	08

	Soft matter Smart composites: Active fiber composites/smart polymer matrix composites	
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	06
4	**Nanomaterials and Biomaterials** Nanomaterials: Concept, classification, Size effect on structural and functional properties, Synthesis of nanomaterials – Top down and bottom up approaches, Issues and applications of nanomaterials in various industries, Special nanostructures (Fullerene, Graphene, Carbon nanotubes etc) and their application, Nanocomposites and Nanotechnology. Biomaterials: Need for biomaterials, biocompatibility, types of biomaterials and applications in orthopedic, dental, cardiovascular and biomedical devices.	06
5	**Materials for Energy Storage and Harvesting** Materials used for storage and conversion of various source of energy such as electrical, electrochemical, photo-electrochemical, thermal and mechanical energy. Smart materials for energy harvesting. Hydrogen storage materials.	06
6	**Processes Applied for 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.	05
	Total	**39**

Advanced Materials & Processes Laboratory (DJS22MEEL5011)

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:

2. Chander Prakash, Sunpreet Singh, and J. Paulo Davim, Functional and Smart Materials, CRC Press, 2021.
3. Rachid Bouhfid & Abou el Kacem Qaiss & Mohammad Jawaid, Polymer Nanocomposite-Based Smart Materials, Elsevier Science, 2020.
4. Masoud Mozafari, Handbook of Biomaterials Biocompatibility, Woodhead Publishing, 2020.
5. Aguilar, Maria Rosa, Roman, Julio San, Smart polymers and their applications, Woodhead Publishing, 2019.
6. Anca Filimon, Smart materials- Integrated Design, Engineering Approaches, and Potential Applications, Apple Academic Press, 2019.
7. Cheong K.Y., Impellizzeri,G and Fraga,M.A.,(2018, Emerging Materials for Energy Conversion and Storage, 1st Edition, Elsevier, 2018
8. Ying-Pin Chen,Sajid Bashir,Jingbo Louise Liu, Nanostructured Materials for Next-Generation Energy Storage and Conversion, Springer, 2017.

9. Li, Qing;Mai, Yiu-Wing, Biomaterials for Implants and Scaffolds, Springer, 2017.
10. Epaarachchi, Jayantha Ananda; Kahandawa, Gayan Chanaka, Structural health monitoring technologies and next-generation smart composite structures, CRC Press, 2016.
11. Hou, Xu, Design, fabrication, properties, and applications of smart and advanced materials, CRC Press, 2016.
12. Yoseph Bar-Cohen, High Temperature Materials and Mechanisms, CRC Press, 2014.
13. William G. Fahrenholtz; Eric J. Wuchina; William E. Lee; Yanchun Zhou, Ultra-High Temperature Ceramics: Materials for Extreme Environment Applications, Wiley, 2014.
14. Rani Elhajjar; Valeria La Saponara; Anastasia Muliana, Smart Composites: Mechanics and Design, CRC Press, 2013.
15. C. Mauli Agrawal, Joo L. Ong, Mark R. Appleford, Gopinath Mani, Introduction to Biomaterials: Basic Theory with Engineering Applications, Cambridge University Press, 2013.
16. J. L. Zhong, Smart Materials and Nanotechnology in Engineering, Trans Tech Pubn, 2012.
17. Mel Schwartz, Smart Materials, CRC Press, 2008.

Web Resources:

1. Prof. Jayanta Das, Advanced Materials and Processes, NPTEL Ccourse, IIT Kharagpur, 2019.
2. Prof. Kaushik Pal., Selection of Nanomaterials for Energy Harvesting and Storage Application, NPTEL Course, IIT Roorkee, 2019.
3. Bhattacharya B, Smart Materials and Intelligent System Design, NPTEL Ccourse, IIT Kanpur, 2018.

Program: Mechanical Engineering	T.Y B.Tech	Semester: V
Course: Automobile Engineering (DJS22MEC5012)		
Course: Automobile Engineering Laboratory (DJS22MEL5012)		

Pre-requisite: --

1. Manufacturing processes, mechanics of materials
2. Fluid mechanics
3. Basic electronics

Objectives:

1. To impart the understanding of important mechanical systems of an automobile.
2. To impart the understanding of the electrical and electronic systems of an automobile.
3. To familiarize with the latest technological developments in automotive technology.

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

1. Describe the types and working of clutch and transmission system.
2. Illustrate the working of steering and braking systems.
3. Describe the role of vehicle suspension systems and vehicle body.
4. Describe the different automotive electrical and electronic systems.
5. Acquaint with recent developments in automobiles.

Automobile Engineering (DJS22MEC5012)		
Unit	**Description**	**Duration**
1	**Introduction:** Classification of automobiles, Importance of various sub-systems of an automobile, development of an automobile, aspects of automotive engineering. **Clutch:** Performance characteristics of a prime mover, requirements & types of clutches, single plate, multi-plate, wet clutch, centrifugal clutch. Clutch materials. Clutch operating Mechanisms-Mechanical, Electric, Hydraulic and Vacuum. Trouble shooting and remedies. Clutch-by-wire. **Transmission:** Requirements of gear box. Sliding mesh, Constant mesh, and Synchromesh Gearbox. Gear selector mechanisms. Overdrives, under-gearing, over-gearing, tractive effort and hydrodynamic torque converter, Epicyclic gear train and automatic transmissions. Trouble shooting and remedies. Automated Manual Transmission (AMT), Continuously Variable Transmission (CVT), Dual Clutch Transmission (DCT). **Final Drive and Differential:** Types of Final drive; spiral, bevel, Hypoid and worm drives. Necessity of differential, Working of differential, Conventional and limited-slip differential, Trouble shooting and remedies.	**08**
2	**Propeller Shaft and Axle:** Propeller shafts and universal joints: Types and construction, Different types of universal joints and constant velocity joints. Classification of axles, Loads	

	on axles, Semi, Three quarter and Full floating axles. Trouble shooting and remedies **Steering System:** Steering requirements, steering linkages and steering gears. Steering geometry, Analysis of steering geometry, Over-steer and Under-steer, Reversibility of steering gears. Trouble shooting and remedies. **Braking System:** Requirement of brakes, Classification of brakes, Brake Actuation Methods: Mechanical, Hydraulic, Pneumatic, Electro and vacuum brakes. Types of Disc brakes and Drum Brakes, Brake trouble shooting, Antilock braking system (ABS).	**07**
3	**Suspension System:** Objects of suspension, Basic requirements, Sprung and un-sprung mass, Types of Independent, semi-independent and rigid axle suspension. Air suspension and its features. Pitching, rolling and bouncing. Shock absorbers and its types, Trouble shooting and remedies. Electronically controlled active suspension system. **Wheels and Tyres:** Requirements of wheels and tyres. Types of wheels, types of tyres and types of carcass. Tyre and wheel manufacturing processes. Trouble shooting and remedies. Airless tyres & run flat tyres.	**07**
4	**Body Engineering:** Importance of vehicle body and its types. Loads on vehicle body, materials for body construction. Layouts of passenger cars, Bus and truck bodies. Chassis types and structure types: Open, Semi integral and integral structures. Frames: Types of frames and their functions, Loads on frames, Load distribution of structure. Importance of crumple zone in vehicles, Crash safety ratings in India.	**06**
5	**Automotive electronics:** **Storage Systems:** Lead-Acid Battery; construction, working, ratings, types of charging methods, Alkaline battery, ZEBRA and Sodium Sulphur battery. Lithium ion battery, battery pack for electric vehicles, Battery management system. Solid state battery. **Vehicle Sensors:** Vehicle speed sensor, Mass air flow sensor, temperature sensor, MAP sensor, Lambda sensor, TP sensor, Steering angle sensor, Acceleration sensor, Yaw rate sensor, Airbag sensor, Radar, LiDAR sensor.	**06**
6	**Recent developments in Automobiles:** Active and Passive Safety systems in an automobile. Cruise Control, Adaptive Cruise Control (ACC), Predictive Cruise Control, Electronic Stability Program (ESP), Electronic Brake Distribution System (EBD), Traction Control System (TCS). Integrated Starter Alternator (ISA), Hill assist, Launch control, Connected cars with V2V communication & pre-collision technology.	**05**
	Total	**39**

Automobile Engineering Laboratory (DJS22MEL5012)	
Exp.	**Suggested experiments**
1	Identify and illustrate various components in a clutch assembly.
2	Simulation of powertrain systems on Lotus Engineering Software
3	Simulation of powertrain systems on MATLAB Simulink software.
4	Simulation and analysis of transmission system gear ratio using MATLAB Simulink software
5	Simulation and analysis of braking system using MATLAB Simulink software
6	Modeling and FEA analysis of vehicle frame designs and materials on ANSYS / Solidworks
7	Characterization and visualization of output of various sensors such as TPS, MAP, ECT sensor.
8	Simulation of cruise control system using MATLAB Simulink software
9	Case study presentations on upcoming vehicle technologies

Minimum seven 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:

Text books:

1. Automobile Engineering, Dr. Kirpal Singh, Vol I & II, 13th Edition, Standard publishers
2. Automobile Engineering, S. K. Gupta, S Chand Publications
3. Automobile Engineering, R. K. Rajput, 2nd Edition, Laxmi Publications

Reference Books:

1. Automotive Engineering Fundamentals, Jeffrey Ball, Richard Stone, SAE International.
2. Encyclopedia of Automotive Engineering, David Crolla, Wiley Publication
3. Automotive Electrical and Electronic Systems, Tom Denton, 5th Edition, Routledge
4. Modern Electric, Hybrid Electric, and Fuel Cell Vehicles, Mehrdad, Yimin, Sebastian, Ali, 3rd Edition, CRC Press

Program: Mechanical Engineering	T.Y B.Tech	Semester: V
Course: Reliability Engineering (DJS22MEC5013)		
Course: Reliability Engineering Laboratory (DJS22MEL5013)		

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 inculcate basic knowledge on the applications of probability distributions in modeling and analyzing failure data.
2. To be familiar with the techniques used in system reliability modeling and analyze warranty data.
3. To provide a basic understanding of the use of probabilistic approaches to design components and predict reliability
4. To acquaint with the concepts of reliability testing.

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

1. Apply 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 the 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 for testing of components.

Reliability Engineering (DJS22MEC5013)		
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.	07
2	**Probability Distributions** Discrete probability distribution - Binomial distribution, Poisson distribution. Continuous Probability Distributions – Weibull, exponential, normal (Gaussian), and lognormal. Concept of confidence interval.	07
3	**System Reliability:** System Configurations: Series, parallel, mixed configuration, k out of n structure, Complex systems. Successful Path method, Decomposition method. Tie-set and Cut-set methods. Logic diagrams.	07

	Reliability Improvement: Redundancy Techniques: Element redundancy, Unit redundancy, Standby redundancies.	
4	**System Reliability Modelling and Warranty Analysis** Failure Modes and Effects Analysis (FMEA), and Fault Tree Analysis (FTA). Product warranty and reliability.	06
5	**Probabilistic Design:** Design for reliability, Reliability models for probabilistic design, Relationship between reliability, the factor of safety and variability. **Maintainability –** types of maintenance, models for maintenance data. **Availability –** Types, Markov chains.	06
6	**Reliability Testing** Introduction to reliability testing, Stress strength interaction, Accelerated Life Testing and Highly Accelerated Life Testing (HALT), and highly accelerated stress Screening (HASS). Handbook-based reliability predictions	06
	Total	**39**

Reliability Engineering Laboratory (DJS22MEL5013)	
Exp.	**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 best-fit probability distributions for reliability modelling using a suitable approach (Use data from paper clips experiments).
3	A case study on reliability block diagrams.
4	A case study on fault tree analysis.
5	A case study FMEA analysis using MIL-STD-1629.
6	A case study on Markov chains/ Monte Carlo simulation
7	Physics of failure models/ Warranty data analysis
8	A case study on reliability allocation (ARINC/ AGREE/ Feasibility of objectives/ Aggarwal's method/ and Integrated factor).
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

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 10 can be performed.

Books Recommended:

Textbooks:

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

Reference Books:

1. E. Balagurusamy, "Reliability Engineering", Tata McGraw Hill, 2017.
2. M. Modarres, K. Kaminsky, and V. Krivstov, "Reliability Engineering and Risk Analysis – A Practical Guide", CRC Press, Taylor and Francis Group, 2017.
3. P. D. T. O'Conner, "Practical Reliability Engineering", John Wiley and Sons, 2012.
4. G. Yang, "Life cycle reliability engineering", John Wiley and Sons, 2007.
5. 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: Power Engineering (DJS22MEC5014)		
Course: Power Engineering Laboratory (DJS22MEL5014)		

Objectives:

1. To study boilers, boiler mountings and accessories
2. To study steam turbines, hydraulic turbines and their utilities
3. To study pumps, compressors and their utilities

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

1. Recognize different types of boilers and evaluate steam generator, steam turbine performance.
2. Identify basic concepts in the case of centrifugal compressors and evaluate their performance.
3. Demonstrate working of axial flow compressors and evaluate their performance.
4. Identify basic difference between impulse and reaction water turbines, investigate various parameters and design turbine runners.
5. Define operating principles of reciprocating and centrifugal pumps and evaluate their performance.

Power Engineering (DJS22MEEC5014)		
Unit	**Description**	**Duration**
1	**Steam Generators** Fire tube and Water tube boiler, Low pressure and high-pressure boilers, once through boiler, examples, and important features of HP boilers, Mountings and accessories, Equivalent evaporation of boilers, Boiler performance and Boiler efficiency.	**04**
2	**Steam Nozzle** Flow through steam nozzle-velocity at exit and condition for maximum discharge, nozzle efficiency. **Steam Turbine** Basic of steam turbine, Classification, compounding of turbine, Impulse turbine – velocity diagram, Condition for max efficiency, Reaction turbine - velocity diagram, degree of reaction, Parson's turbine, Condition for maximum efficiency.	**06**
3	**Rotary Compressors** Vane type compressors, Scroll & Screw compressors etc. **Centrifugal compressors** Work required, polytropic efficiency, pressure rise, slip, effect of blade shape, two-dimensional flow through impeller; Vaned diffuser and volute casing; Surging and choking of compressors; Compressor performance and characteristic curves.	**05**
4	**Axial flow compressors** Work required, polytrophic efficiency, pressure rise, degree of reaction; Simple design calculations; Surging and stalling of compressors; Compressor performance and characteristic curves.	**04**
5	**Hydraulic Turbines** Introduction to hydrodynamic thrust of jet on a fixed and moving surface (flat & curve), Types of hydro turbines - impulse and reaction, definition of various turbine parameters	**10**

	like gross head, discharge, work done, input power, output power, efficiencies etc., Eulers' equation applied to a turbine, turbine velocities and velocity triangles, expression for work done. **Impulse Turbine** Components of Pelton turbine, definition of design parameters like speed ratio, jet ratio, and estimation of various parameters like head, discharge, and efficiency etc., determination of number of buckets. **Reaction Turbines** Types of reaction turbines - inward and outward flow, Francis turbine, Kaplan turbine; elements of the turbine, estimation of various parameters. Unit quantities in turbines.	
6	**Pumps** Classification of pumps: positive displacement and non - positive displacement **Positive Displacement pumps** Types and applications, general features of rotary pumps, general feature of reciprocating pumps, definition of head, discharge, work done and efficiency, types of reciprocating pumps, indicator diagram, use of air vessel. **Centrifugal Pumps** Types - radial flow, mixed flow and axial flow, priming of pumps, components of the pump, Euler's equation and velocity triangles, correction factors for the head, design constant e.g., head constant, flow constant etc. self-priming pumps, series and parallel operation of pumps, system curve, determination of operating point, Cavitation in pumps, Determination of available and required NPSH, Model testing, Dimensional analysis. **Submersible Pumps** Types and applications, general features of submersible pumps, work done and efficiency.	**10**
	Total	**39**

Power Engineering Laboratory (DJS22MEL5014)	
Exp.	**Suggested experiments**
1	Study/Demonstration of Boilers
2	Study/Demonstration of Boiler mountings and accessories
3	Study of Steam Turbine
4	Trial on Impulse turbine (Pelton Wheel)
5	Trial on Reaction water turbine (Francis / Kaplan turbine)
6	Study of Rotary compressors
7	Trial on Positive displacement pump
8	Trial on Single stage centrifugal pump
9	Trial on Multistage centrifugal pump
10	Demonstration of different components of Centrifugal pump by dismantling the pump system.

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.

Assignments:

Minimum five assignments based on syllabus (covering numerical).
A Mini project relevant to the subject may be included, which would help the learner to apply the concept learnt.

Books Recommended:

Reference Books:

1. Thermal Engineering, R K. Rajput, 10th edition, Laxmi Publication
2. Thermal Engineering, Kothandraman, Domkundwar, Khajuria, Arora, 5th edition, 2002, Dhanpatrai & Sons
3. Thermal Engineering, Ballaney P.L., 25th edition, 2015, Khanna Publishers.
4. Steam & Gas Turbines and Power Plant Engineering, R. Yadav, 7th edition, 2000, Central Publishing house Allahabad
5. Fluid Mechanics and Fluid Machines, D.S. Kumar, 2013, S.K. Kataria & Sons
6. Fluid Mechanics and Machinery, C. S. P. Ojha, P. N. Chandramouli, R. Berndtsson, 2010, Oxford University Press
7. Fluid Mechanics and Hydraulic Machinery, P. N. Modi and S. M. Seth, 17th edition, 2011, Standard Book House.
8. Hydraulic Machines, R K Rajput, S.Chand Publication.
9. Fluid Mechanics and Fluid Machines, Bansal R.K, 9th edition, 2015, Laxmi Publications.
10. Turbines, Fans and Compressors; Yahya S.M, 4th edition, 2011, Tata McGraw Hill.

Program: Mechanical Engineering	T.Y. B.Tech	Semester: V
Course: Data Analytics (DJS22MEC5015)		
Course: Data Analytics Laboratory (DJS22MEL5015)		

Pre-requisite:

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.
6. Apply data science concepts and methods to solve problems in a real-world context

Data Analytics for Mechanical Engineering (DJS22MEC5015)		
Unit	**Description**	**Duration**
1	**Introduction** Data science and data analytics; Types of data, Data recording/ collecting; 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, Database system.	**5**
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.	**5**
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.	**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;	**6**

	Diagnostics analytics – root cause analysis, data mining, correlation, product quality analysis	
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.	**8**
6	**Applications** 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	**6**
	Total	**39**

Note – Numerical should be related to mechanical and allied engineering domains.

Data Analytics Laboratory (DJS22MEL5015)	
Exp.	**Suggested experiments**
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	To develop a regression model and evaluate its performance (any one algorithm).
4	To develop a classification model and evaluate its performance (any one algorithm).
5	To conduct hypothesis tests using p-test/ Chi-Square test/ z-test/ t-test/ ANOVA/ K-S test.
6	To visualize a given data set (paperclip tests/ literature/ laboratory) - scattered diagram, Bar/ line chart, histogram, Box plots, and pie charts.
7	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.
8	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 3-4 students) based on the above contents and using the mechanical engineering application dataset.	

Books Recommended:

Textbooks:

1. Brunton, S. L., & Kutz, J. N. (2022). Data-driven science and engineering: Machine learning, dynamical systems, and control. Cambridge University Press.
2. Dunn, P. F., & Davis, M. P. (2017). Measurement and data analysis for engineering and science. CRC press.
3. Roy, S. S., Samui, P., Deo, R., & Ntalampiras, S. (Eds.). (2018). Big data in engineering applications (Vol. 44). Berlin/Heidelberg, Germany: Springer.

4. Middleton, J. A. (2021). Experimental Statistics and Data Analysis for Mechanical and Aerospace Engineers. Chapman and Hall/CRC.
5. Brandt, S. (1970). Statistical and computational methods in data analysis.
6. Robinson, E. L. (2017). Data analysis for scientists and engineers. In Data Analysis for Scientists and Engineers. Princeton University Press.
7. Araghinejad, S. (2013). Data-driven modeling: using MATLAB® in water resources and environmental engineering (Vol. 67). Springer Science & Business Media.
8. Niu, G. (2017). Data-driven technology for engineering systems health management. Beijing, China: Springer.

Reference Books:

1. Zsolt Nagy, "Artificial Intelligence and Machine Learning Fundamentals", Packt Publishing, 2018, ISBN: 978-1-78980-165-1
2. 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.
3. Zaki, Mohammed J., Wagner Meira Jr, and Wagner Meira. Data mining and analysis: fundamental concepts and algorithms. Cambridge University Press, 2014.
4. Kumar, Zindani, Davim, Artificial Intelligence in Mechanical and Industrial Engineering, CRC Press, 2021.

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: Incubation, Entrepreneurship and Startups (DJS22MEC5016)		
Course: Incubation, Entrepreneurship and Startups Laboratory (DJS22MEL5016)		

Pre-requisite:

1. Nil

Objectives:

1. To enable participants in exploring the Startup World:
   - Investigate global startup stories and the role of incubators in fostering growth.
2. To foster an entrepreneurial mindset in participants:
   - Develop creative problem-solving skills applicable to diverse challenges.
3. To guide participants in building effective Business Models:
   - Learn the art of creating versatile business plans and understanding customer needs.
4. To assist participants in understanding Tech and Innovation:
   - Explore the intersection of technology and entrepreneurship, and basics of idea protection.
5. To educate participants on Fundraising for Innovative Ventures:
   - Explore diverse fundraising avenues and strategies to impress potential investors.
6. To equip participants for Execution and Growth:
   - Develop skills for turning plans into action and strategies for sustained startup growth.

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

1. Effectively Navigate the Global Startup Landscape:
   - Understand and navigate the global startup ecosystem, recognizing the role of incubators.
2. Cultivate an Entrepreneurial Mindset:
   - Develop creative problem-solving skills applicable to diverse challenges.
3. Create Effective Business Models:
   - Develop versatile business plans, applying lean startup methodologies and addressing customer needs.
4. Navigate Technology and Innovation:
   - Understand the intersection of technology and entrepreneurship, including the protection of intellectual property.
5. Master Fundraising Strategies:
   - Evaluate diverse fundraising avenues and impress potential investors with innovative ideas.
6. Execute and Foster Growth:
   - Apply skills for effective startup execution and explore strategies for sustained growth.

Incubation, Entrepreneurship and Startups (DJS22MEC5016)		
Unit	**Description**	**Duration**
1	**Understanding the Entrepreneurial Ecosystem** • Introduction to Entrepreneurship and Startups • Global and Local Entrepreneurial Landscapes • Role of Incubators and Accelerators • Case Studies of Successful Startups • Guest Lectures from Entrepreneurs and Incubator Managers	**8**

2	**Developing a Startup Mindset** • Cultivating an Entrepreneurial Mindset • Design Thinking and Creativity in Mechanical Engineering • Innovation and Idea Generation • Practical Exercises and Workshops on Creative Problem Solving • Group Projects: Ideation and Concept Development	**8**
3	**Business Model Development** • Introduction to Business Models • Lean Startup Methodology • Customer Validation and Market Research • Prototyping and Minimum Viable Product (MVP) • Business Model Canvas Workshop • Pitching Practice: Presenting Business Models	**6**
4	**Technological Innovation and Intellectual Property** • Technology Readiness Levels (TRLs) • Technology and Entrepreneurship • Intellectual Property Basics (Patents, Trademarks, Copyrights) • Patent Search and Analysis • Strategies for Protecting Intellectual Property • Ethical Considerations in Technology and Innovation	**6**
5	**Fundraising and Investment Strategies** • Fundraising Options for Start-ups • Indian government schemes for start-ups and entrepreneurs. • Angel Investors and Venture Capital • Crowdfunding Platforms • Financial Modelling for Startups • Crafting an Effective Pitch • Mock Pitch Sessions and Feedback	**6**
6	**Execution and Scaling** • Challenges in Startup Execution • Operations and Logistics for Startups • Scaling Strategies for Mechanical Engineering Startups • Case Studies of Startup Success and Failure • Final Project: Develop and Present a Comprehensive Startup Plan • Course Review and Reflection	**5**
		39

Incubation, Entrepreneurship and Startups Laboratory (DJS22MEL5016)	
Sr. No.	**Exercises**
1	Market Research Simulation: Conduct a simulated market research project to identify potential customer needs and preferences for a startup idea.
2	Business Model Canvas Workshop: Collaboratively create a Business Model Canvas for a startup concept, emphasizing key components like value proposition, customer segments, and revenue streams.

3	Prototyping Challenge: Design and build a prototype of a product or service related to mechanical engineering, emphasizing rapid prototyping techniques.
4	Intellectual Property Workshop: Explore case studies and scenarios related to intellectual property in the context of startups, fostering an understanding of patenting, trademarks, and copyrights.
5	Pitching Practice Session: Engage in pitching sessions where students present their startup ideas, receiving constructive feedback from peers and instructors.
6	Financial Modelling Exercise: Develop a financial model for a startup project, considering costs, revenue projections, and potential investment scenarios.
7	Angel Investing Simulation: Simulate an angel investing scenario where students evaluate and decide on potential investments in startup projects.
8	Crowdfunding Campaign Design: Design a crowdfunding campaign for a startup idea, including the creation of promotional materials, goals, and rewards.
9	Startup Execution Simulation: Participate in a simulation that mirrors the challenges of executing a startup plan, allowing students to make decisions and adapt to changing circumstances.
10	Scaling Strategies Discussion: Analyse and discuss different strategies for scaling a startup, considering factors such as market expansion, partnerships, and technology adoption.

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:

Text Book

1. “Technology Entrepreneurship”, Taking Innovation to the Marketplace by Thomas N. Duening.
2. “Entrepreneurship Trajectories”, by Diego Matricano
3. "Entrepreneurship Development in India" by Vasant Desai

Reference Books:

1. "The Lean Startup: How Today's Entrepreneurs Use Continuous Innovation to Create Radically Successful Businesses" by Eric Ries
2. "Business Model Generation: A Handbook for Visionaries, Game Changers, and Challengers" by Alexander Osterwalder and Yves Pigneur
3. "Zero to One: Notes on Startups, or How to Build the Future" by Peter Thiel and Blake Masters
4. "The Art of Startup Fundraising: Pitching Investors, Negotiating the Deal, and Everything Else Entrepreneurs Need to Know" by Alejandro Cremades
5. "The Innovator's Dilemma: When New Technologies Cause Great Firms to Fail" by Clayton M. Christensen
6. "Venture Deals: Be Smarter Than Your Lawyer and Venture Capitalist" by Brad Feld and Jason Mendelson
7. "Disciplined Entrepreneurship: 24 Steps to a Successful Startup" by Bill Aulet
8. "The Startup Owner's Manual: The Step-By-Step Guide for Building a Great Company" by Steve Blank and Bob Dorf

9. "Crossing the Chasm: Marketing and Selling Disruptive Products to Mainstream Customers" by Geoffrey A. Moore
10. "The Founder's Dilemmas: Anticipating and Avoiding the Pitfalls That Can Sink a Startup" by Noam Wasserman
11. "Entrepreneurship Development in India" by S. Anil Kumar
12. "Entrepreneurship: Theory and Practice" by Dr. S. Ramesh Kumar
13. "Indian Entrepreneurship: Analysis of Business Practices" by Rajat K Baisya
14. "Start-up Sutra: What the Angels Won't Tell You About Business and Life" by Rohit Prasad
15. "Entrepreneurship Development in India" by Vasant Desai
16. "Startup Capitals: Discovering the Global Hotspots of Innovation" by Zafar Anjum
17. "From Start-Up to Global Success: The Zensar Story" by Ganesh Natarajan
18. "India's Intellectual Property Landscape: Lessons from the Biotechnology and Pharmaceutical Industries" by Kshama V. Kaushik
19. "The Making of India: Gamechanging Transitions" by Akhilesh Tilotia
20. "The Mouse Charmers: Digital Pioneers of India" by Anuradha Goyal

Program: Mechanical Engineering	T.Y. B.Tech	Semester: V
Course: Prototyping and Design Validation (DJS22MEC5017)		
Course: Prototyping and Design Validation Laboratory (DJS22MEL5017)		

Pre-requisite: --

1. Fundamentals of Mechanical Engineering

Objectives:

1. Understand the importance of prototyping in product development and design validation.
2. Learn various prototyping techniques and tools, including low-fidelity and high-fidelity prototyping methods.
3. Develop skills in gathering and interpreting user feedback to inform prototyping decisions.
4. Explore strategies for rapidly iterating on prototypes to refine product concepts.
5. Gain experience in effectively communicating and presenting prototype designs to stakeholders.

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

1. Explain the role of prototyping in product development and design validation.
2. Compare various methods of prototyping and select a suitable method for a given application.
3. Demonstrate proficiency in utilizing various prototyping technologies and techniques.
4. Plan and execute design validation tests, including usability, functional, and compliance testing.
5. Understand regulatory and compliance requirements and integrate them into the design validation process.

Prototyping and Design Validation (DJS22MEC5017)		
Unit	**Description**	**Duration**
1	**Introduction to Prototyping and Design Validation** • Product design and development process. • Need and role of prototyping in product development. • Dimensions of prototyping (four quadrants). • Prototyping process. • Business case for prototyping. • Concept, need, and goals of product validation. • Overview of design validation methodologies. • Challenges and considerations.	4
2	**Classification of Prototyping Techniques** • **Low-fidelity prototyping:** sketching, wireframing, paper, storyboarding, and card sorting. • Mid-fidelity prototyping. • **High-fidelity prototyping:** interactive, functional, Augmented Reality (AR), Virtual Reality (VR), simulation and emulators, high-fidelity mockups. • Other approaches: digital/ virtual prototyping, physical prototyping, functioning prototyping, iterative prototyping. • Selecting the appropriate prototyping method. • **Prototype scale:** Full-, half-, quarter-, desktop-, micro-, and macro-scale.	10

3	**Prototyping Technologies - I** • 3D printing, CNC machining, Injection molding, Vacuum casting, Laser cutting and engraving, Foam modeling, and Soft prototyping. • Physical prototyping materials and tools.	5
4	**Prototyping Technologies - II** • Prototyping software for 3D modeling and CAD. • Interactive mockup tools. • Code-based prototyping. • Accessibility and inclusive design tools. • Prototyping kits and templates. • Cloud-based prototyping and collaboration platforms.	5
5	**Prototyping Planning, Execution, and Design Validation** • Planning prototyping activities: define goals, objectives, requirements and constraints. • conceptualize and ideate: generate initial design concept. • Select prototyping method. • Develop prototype design: translating requirements and constraints into prototype. • Prototype fabrication. • Tests for design validation: functionality, performance, usability, reliability, etc. qualitative and quantitative testing methods to gather feedback from users and stakeholders. • Iterate and refine. • Finalize Design. • Document and communicate.	8
6	**Regulatory Compliance and Standards** • Importance of regulatory requirements, compliance, and industry standards. • Regulatory agencies and bodies: FDA, ISO, ASTM, etc. • Industry-specific regulations: medical devices, automotive, aerospace, etc. • Types of compliance testing: safety, performance, environmental, electromagnetic compatibility (EMC), etc. • Laboratory testing vs. field testing: advantages and limitations. • Impact of regulatory requirements on prototype planning, design and materials selection. • Incorporating compliance considerations into the design validation process. • Risk assessment and mitigation strategies in compliance testing. • Documentation and recordkeeping; data management strategies. • Case studies: Compliance testing and regulatory challenges.	7
		39

Prototyping and Design Validation Laboratory (DJS22MEL5017)	
Exp.	**Suggested Experiments/ Exercises/ Assignments**
1	Study the role of prototyping in the product design and development process.
2	Low-fidelity prototyping: sketching, wireframing, paper, storyboarding, and card sorting.
3	Mid-fidelity prototyping.

4	High-fidelity prototyping: interactive, functional, Augmented Reality (AR), Virtual Reality (VR), simulation and emulators, high-fidelity mockups.
5	Selecting the appropriate prototyping method and scale (Full-, half-, quarter-, desktop-, micro-, and macro-scale).
6	3D printing/ CNC machining/ Injection molding/ Vacuum casting/ Laser cutting and engraving/ Foam modeling/ and Soft prototyping.
7	Prototyping software for 3D modeling and CAD/ Interactive mockup tools/ Code-based prototyping/ Accessibility and inclusive design tools/ Prototyping kits and templates.
8	Cloud-based prototyping and collaboration platforms.
9	Prototyping materials and tools.
10	Study on the prototyping planning and execution process
11	Study on the various regulatory compliance and standards (in a group of 3-4 students)
12	Types of compliance testing: safety, performance, environmental, electromagnetic compatibility (EMC), etc.

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

Books Recommended:

Textbooks:

1. Prototyping and Modelmaking for Product Design by Bjarki Hallgrimsson, 2nd Edition, Quercus Publishing, 2023.
2. Rapid Prototyping: Principles and Applications in Manufacturing by Chua, C.K., Leong, K.F., John Wiley and Sons Inc., 2003.
3. Rapid Prototyping: Principles and Applications by Noorani, R., John Wiley & Sons, Inc., New Jersey, 2006.

Reference Books:

1. Prototyping: A Practitioner's Guide by Todd Zaki Warfel, Rosenfeld Media 2009.
2. Prototype: Design and Craft in the 21st Century, by Louise Valentine, Bloomsbury Publishing 2013.
3. Product Design and Development" by Karl T. Ulrich and Steven D. Eppinger, McGraw-Hill/Irwin, 2012.

Web References:

- Electronics equipment integration and Prototype building - https://nptel.ac.in/courses/108108157
- Physical Modelling for Electronics Enclosures using Rapid prototyping - https://nptel.ac.in/courses/108108115

Program: Mechanical Engineering	**T.Y B. Tech**	**Semester: V**
Course: Environmental Studies (DJS22A3)		

Pre-requisite: Interest in Environment and its impact on Human

Objectives:

1. Understand environmental issues such as depleting resources, pollution, ecological problems and the renewable energy scenario.
2. Familiarize environment related legislation
3. Understand and compare solar energy

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

1. Understand how human activities affect environment
2. Understand the various technology options that can make a difference
3. Identify the advantages of solar energy over other forms of energy

Environmental Studies (DJS22A3)		
Unit	**Description**	**Duration**
1	**Social Issues and Environment** • Ecological footprint and Carrying Capacity • Depleting nature of Environmental resources such as soil, water minerals and forests • Carbon emissions and Global Warming. • Concept of Carbon credit, • Green Building	5
2	**Technological growth for Sustainable Development** • Social, Economical and Environmental aspects of Sustainable Development • Renewable Energy Harvesting • Power and functions of Central Pollution Control Board and State Pollution Control Board	5
3	**Solar Energy** • Basic concept of Solar Radiation • Study of Solar panels • Comparative study of Solar energy with other energy sources	3

Books Recommended:

Text books:

1. *Environmental Studies from Crisis to Cure, R. Rajagopalan, 2012*
2. *Textbook of Environmental Studies for Undergraduate Courses, Erach Bharucha*
3. *Solar Engineering Sukhatme*

Prepared by Checked by Head of the Department Principal

Program: Mechanical Engineering	T.Y. B. Tech	Semester: V
Course: Innovative Product Development III (DJS22ILLL1)		

Pre-requisite: --

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.
4. 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.
5. 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 analyse the impact of the proposed method of design and development of the product.
6. Develop interpersonal skills, while working as a member of the team or as the leader.
7. Demonstrate capabilities of self-learning as part of the team, leading to life-long learning, which could eventually prepare themselves to be successful entrepreneurs.
8. Demonstrate product/project management principles during the design and development work and also excel in written (Technical paper preparation) as well as oral communication.

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 in the team shall understand the effective need for product development and accordingly select the best possible design in consultation with the faculty supervisor.
- Students shall convert the best design solution into a working model, using various components drawn from their domain as well as related interdisciplinary areas.
- Faculty supervisor may provide inputs to students during the entire span of the activity, spread over **2 semesters**, wherein the main focus shall be on self-learning.

- A record in the form of an activity log-book is to be prepared by each team, wherein the team can record weekly progress of work. The guide/supervisor should verify the recorded notes/comments and approve the same on a weekly basis.
- The design solution is to be validated with proper justification and the report is to be compiled in a standard format and submitted to the department. Efforts are to be made by the students to try and publish a technical paper, either in the institute journal, "Techno Focus: Journal for Budding Engineers" or at a suitable publication, approved by the department research committee/ 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 V and VI.

Guidelines for Assessment of the termwork:

1. 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.
2. 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.
3. Distribution of marks individually for the both reviews as well as for the first review during the subsequent semester shall be as given below:
   A. Marks awarded by the supervisor based on log-book : 10
   B. Marks awarded by review committee : 10
   C. Quality of the write-up : 05

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 the 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.
4. Innovativeness in the proposed design.
5. Feasibility of the proposed design and selection of the best solution.
6. Cost effectiveness of the product.
7. Societal impact of the product.
8. Functioning of the working model as per stated requirements.
9. Effective use of standard engineering norms.
10. Contribution of each individual as a member or the team leader.
11. 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 design and the development of the product shall be assessed through a presentation and demonstration of the working model by the student team to a panel of Internal and External Examiners, preferably from industry or any research organizations having an experience of more than five years, approved by the Head of the Institution. The presence of the external examiner is desirable only for the 2nd presentation in semester VI. Students are compulsorily required to present the outline of the technical paper prepared by them during the final review in semester VI.

Semester VI

Program: Mechanical Engineering	T.Y. B.Tech	Semester: VI
Course: Design of Machine Elements (DJS22MEC601)		
Course: Design of Machine Elements Laboratory (DJS22MEL601)		

Pre-requisite: --

1. Mechanics of Materials
2. Engineering Materials

Objectives:

1. To study basic principles of design of machine elements.
2. To familiarize with use of design data books & various codes of practice.
3. To acquaint with functional and strength design principles of commonly used machine elements.
4. To make conversant with preparation of working drawings based on designs.

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

1. Use design data books in designing various components and other considerations in design of machine components.
2. Illustrate basic principles of machine design.
3. Demonstrate understanding of various design considerations, theories of failures, Standards/Codes.
4. Design machine elements for static as well as dynamic loading.
5. Design machine elements based on strength/ rigidity concepts.
6. Design of clutches and flexible drives.

Design of Machine Elements (DJS22MEC601)		
Unit	**Description**	**Duration**
1	Introduction to Design of Machine elements: Mechanical Engineering Design, Design methods, Aesthetic and Ergonomics consideration in design, Material properties and their uses in design, Manufacturing consideration in design, Design consideration of casting and forging, Basic Principle of Machine Design: Modes of failures, Factor of safety, Design stresses, Theories of failures, Standards, I.S. Codes, Preferred Series and Numbers.	6
2	Design against Static Loads: Cotter joint, knuckle joint, Bolted and welded joints under eccentric loading; Curved Beams: Assumptions made in the analysis of curved beams, Design of curved beams: Bending stresses in curved beams such as crane hook, C-frame, etc. Power Screw and its application along with the design of Frame-Screw Jack.	10
3	Design against Fluctuating Loads: Variable stresses - reversed, repeated, fluctuating stresses. Fatigue failure: static and fatigue stress concentration factors, Estimation of endurance limit, Design for finite and infinite life, Soderberg and Goodman design criteria, Fatigue design under combined stresses.	5
4	Design of Shaft: power transmitting and power distribution shafts (excluding crankshaft) under static and fatigue loading, Keys: Types of Keys and their selection.	5

	Couplings: Classification of coupling, Design of rigid flange couplings, Bush pin type flexible couplings.	
5	Design of springs: Design of helical compression and tension springs under Static and Variable loads, design of laminated springs. Design of Thin Cylindrical and Spherical Shells: Design of Cylinders, Cylindrical shell with hemi spherical ends and Spheres.	6
6	Design of Flexible curvature drive: Flat belt, V-belt, Rope drive, Selection of Roller Chain drive. Design of friction Clutches: Type of Clutches, Analysis of clutches, design of friction clutch.	7
	Total	**39**

Design of Machine Elements Laboratory (DJS22MEL601)	
Exp.	**Suggested Lab Exercises**
Following assignments are to be solved in the lab sessions in the form of tutorial or any software-based exercises (Minimum six):	
1	Design of Curved Beams
2	Design of Cotter Joint
3	Design of Knuckle Joint
4	Design of screw jack along with frame
5	Design of Bolted and welded joints
6	Design under fluctuating loads (finite and infinite life)
7	Design of Shaft
8	Design of Coupling
9	Design of Helical Spring
10	Design of Laminated Spring
Prepare a layout of following using any CAD software (Minimum two):	
11	Layout of Cotter Joint
12	Layout of Knuckle Joint
13	Layout of C-clamp
14	Layout of Screw jack

Books Recommended:

Textbooks

- V. B. Bhandari, Design of Machine Elements, Tata McGraw-Hill Education, Third Edition, 2010
- J. E. Shigley, Mechanical Engineering Design, McGraw Hill, Sixth Edition, 2001.
- Merhyle Franklin Spotts, Terry E. Shoup, Lee EmreyHornberger, Design of Machine Elements, Pearson/Prentice Hall, Eighth Edition, 2004.

Reference Books:

- Robert L. Norton, Machine Design- An Integrated Approach, Pearson Education Asia, Fifth Edition, 2013.
- M. F. Ashby, Materials Selection in Mechanical Design, Butterworth-Heinemann, Elesevier, 5th Edition, 2017.
- D. N. Reshetov, Machine Design, Mir Publishers Black Adams, Machine Design, McGraw Hill, Third Edition
- Hawrock, Jacobson, Fundamental of Machine Elements, McGraw Hill, Third Edition, 2014.
- V.M. Faires, Design of Machine Elements, The Macmillan Co., Fourth Edition
- P. Orlov, Fundamentals of Machine Design, Mir Publishers, Design Data Book, PSG, 2012
- Design Data Book, Mahadevan, CBS Publishers and Distributors Pvt Ltd, Fourth Edition, 2013.
- PSG Design Data Book

Program: Mechanical Engineering	T.Y. B. Tech	Semester: VI
Course: Finite Element Analysis (DJS22MEC602)		
Course: Finite Element Analysis Laboratory (DJS22MEL602)		

Pre-requisite: --

1. Matrices, Differential Equations and Numerical Integrations.
2. Basics of Mechanics of solids, Thermodynamics and Fluid mechanics.
3. Solid Modelling software.

Objectives:

1. To acquaint learners with the principles of finite element analysis (FEA).
2. To acquaint learners with the applications of FEA for solving engineering problems.
3. To acquaint learners with FEA software for solving real life engineering problems.

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

1. Summarize the finite element method and develop algorithms for the analysis of mechanical systems.
2. Evaluate differential equations using weak and Non-weak form methods.
3. Apply the basic finite element formulation techniques to solve one dimensional engineering problems using bar, beam and link element.
4. Apply the basic finite element formulation techniques to solve two dimensional engineering problems using triangular and quadrilateral elements.
5. Apply the finite element methods to find the natural frequency of dynamic systems.
6. Use modern FEA software/tools to find field variables.

Finite Element Analysis (DJS22MEC602)		
Unit	**Description**	**Duration**
1	**Introductory Concepts**: Historical Background, General FEA procedure, Applications of FEM in various fields, Advantages and disadvantages of FEA. **Definitions of Various Terms used in FEA**: Element, order of the element, internal and external node/s, degree of freedom, primary and secondary variables and boundary conditions. Mathematical Modelling of field problems in engineering, Governing Differential equations in different fields.	**06**
2	**Non-Weak form Methods:** Collocation, Sub-domain, Petrov-Galerkin, Galerkin and Least square method. **Weak form method:** Rayleigh Ritz method for general element and for entire domain. Principle of minimum potential energy.	**06**
3	**One Dimensional Finite Element Formulations:** One dimensional second order equations. Linear and higher order elements. Global, Local and Natural coordinates. Derivation of shape functions, stiffness matrices and force vectors.	**10**

	Assembly of Matrices: solution of problems in one dimensional structural analysis, heat transfer and fluid flow (stepped and taper bars, fluid network and spring-Cart Systems). Analysis of Plane trusses and Analysis of Beams.	
4	**Two Dimensional Finite Element Formulations:** Three node triangular element, four node rectangular element, four node and eight node quadrilateral element. Derivation of shape functions for triangular and quadrilateral element. Sub parametric, Isoparametric, super parametric elements, Compatibility conditions, Patch test, Convergence criterion and sources of errors in FEA.	**08**
5	**Stress Analysis of Two Dimensional Elements:** Equations of elasticity-Plane stress, plane strain and axisymmetric problems. Jacobian matrix, stress analysis of CST and four node Quadrilateral element.	**05**
6	**Finite Element Formulation of Dynamic system:** Applications of FEA to free longitudinal vibration problems. Lumped and consistent mass matrices. **Introduction to Non-linear FEA:** Geometric, material and contact nonlinearity.	**04**
	Total	**39**

Finite Element Analysis Laboratory (DJS22MEL602)	
Exp.	**Suggested experiments**
1	Analysis of bar subjected to an axial load (Stepped/Tapered bar).
2	Analysis of bar subjected to an axial load with thermal effects.
3	Analysis of a beam under various loads.
4	Steady state thermal analysis of a composite wall.
5	Analysis of Plane Truss.
6	Analysis of plate with circular hole at the centre using plane stress/plane strain conditions.
7	Modal analysis of a Mechanical component.
8	Analysis of component using axisymmetric element.

Learners shall use the commercial software (ANSYS/ABAQUS/NASTRAN/HYPERWORKS) or programs (Codes) to perform above experiments. Learners shall also validate the experimental results with manual calculations (wherever applicable). Any other experiment based on syllabus may be included, which would help the learner to understand topic/concept. While performing the analysis of the above suggested experiments, the learners should understand the concepts of selection of element type, meshing and convergence of solution.

Course Project: A group of not more than four students, shall do Finite Element Analysis (using commercial software or program codes) of any mechanical engineering component/system, which involves element selection, assigning material properties, meshing, assigning boundary conditions, analysis and interpretation of results.

Books Recommended:

Text books:

- Seshu P., "Text book of Finite Element Analysis", Prentice-Hall of India Pvt. Ltd., New Delhi, 2012.
- S. S. Rao., "The Finite Element Method Engineering", Butter worth Heinemann, 2010.

Reference Books:

- J. N. Reddy, "Finite Element Method", Tata McGraw Hill, 2019.
- R. Dhanraj and K. Prabhakaran Nair, "Finite Element Methods", Oxford University Press, 2015.
- Logan D. L., "A first course in Finite Element Method", Thomson Asia Pvt Ltd, 2002.
- Cook R. D., Malkus D. S., Plesha M. E., "Concepts and Applications of Finite Element Analysis", John Wiley Sons, 2001.
- Chandrupatla and Belegundu , "Introduction to Finite Elements in Engineering", Prentice Hall, 2002.
- M. Asghar Bhatti., "Fundamental Finite Element Analysis and Application with Mathematica and MATLAB Computations", Wiley India Pvt. Ltd, 2005.

Web references:

1. NPTEL course on Basics of Finite Element Analysis: https://archive.nptel.ac.in/courses/112/104/112104193/
2. NPTEL course on Finite Element Method: https://archive.nptel.ac.in/courses/112/105/112105308/

Program: Mechanical Engineering	**T.Y. B.Tech**	**Semester: VI**
Course: Control Systems (DJS22MEC603)		
Course: Control Systems Laboratory (DJS22MEL603)		

Pre-requisite: --

Objectives:

1. To study concept of mathematical modelling of the control system
2. To acquaint with control system under different time domain

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

1. Represent the systems in Blocks and apply the reduction technique to simplify the system.
2. Design a mathematical model of the system/process for standard input responses.
3. Analyse error and differentiate various types of control systems.
4. Analyse for stability of the given system using different approaches.
5. Apply the basics of Ladder Programming for given control system.

Control Systems (DJS22MEC603)		
Unit	**Description**	**Duration**
1	**Introduction:** Introduction to control systems, Classification of control system. Open loop and closed loop systems. Mathematical modeling of control systems, the concept of the transfer function.	**06**
2	**Control Systems** Block diagram algebra, Reduction of block diagram, Signal flow graphs, Gain formula for signal flow graphs, State diagram from differential equations.	**08**
3	**Time response of dynamic systems:** Time domain performance of control systems: Typical test signal, Unit step response and time domain specifications of first order, second order system. Steady-state error, error constants.	**09**
4	**Stability Analysis:** Control system design and analysis by Root Locus Method, Control system Design by Frequency response method, stability margin, Nyquist diagram, Bode diagram. P, I and D control actions, P, PI, PD and PID control systems, Transient response: Percentage overshoot, Rise time, Delay time, Steady state error, PID tuning (manual), Zigler Method.	**09**
5	**Discrete Control System PLC (Programming Logic Control) Theory:** Introduction to PLC, Architecture, Ladder Logic programming for different types of logic gates, Latching, Timers, Counter, Practical Examples of Ladder Programming	**07**
	Total	**39**

Control Systems Laboratory (DJS22MEL603)	
Exp.	**Suggested experiments**
1	Different Toolboxes in MATLAB, Introduction to Control Systems Toolbox.
2	Determine transpose, inverse values of given matrix
3	Plot the pole-zero configuration in s-plane for the given transfer function.
4	Determine the transfer function for given closed loop system in block diagram representation.
5	Plot unit step response of given transfer function and finds delay time, rise time, peak time and peak overshoot.
6	Determine the time response of given system subjected to any arbitrary input.
7	Plot root locus of given transfer function, locate closed loop poles for different values of k.
8	Determine the steady state errors of a given transfer function.
9	Plot bode plot of given transfer function. Also determine the relative stability by measuring gain and phase margins.
10	Experiments on feedback control systems and servomechanisms
11	System Identification of any one of the sensors
12	Experiment on frequency response system identification
13	Experiment on transient state response of a control system
14	Experiment on transient response of a control system

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. The mode of conduction of experiments can be in either physical mode or Soft mode using the inbuilt Apps or Matlab

Books Recommended:

Text books:

- Franklin G. F., Powell J. D., Emami-Naeini A., Feedback Control of Dynamic Systems, Pearson, Upper Saddle River, New Jersey, 5th edition, 2006.
- K. Ogata, Modern Control Engineering, Prentice Hall of India, 4th edition, 2002
- B. C. Kuo, Farid Gdna Golnaraghi, Automatic Control Systems, PHI, 7th edition, 2003.

Reference books:

- M. Gopal, Control Systems Principles and Design, TMH, New Delhi, 2nd edition,2002
- Norman S. Nise, Control Systems Engineering, John Wiley and Sons, Inc. 2000.
- Francis Raven, Automatic Control Engineering, 5th edition McGraw-Hill International Edition,
- G. C. Goodwin, S. F. Graebe, M.E. Salgado, Control System Design, Pearson education
- Gopal, Control Systems Principles and Design, TMH, New Delhi, 2nd edition, 2002.
- Stefani, Shahian, Savant, Hostetter, Design of Feedback Control Systems, Oxford University Press, 4th edition, 2007.
- Richard C. Dorf, Robert H. Bishop, Modern Control Systems, Addition-Wesley,1999.
- I. J. Nagrath and M. Gopal, Control System Engineering, 3rdEdition, New Age International (P) Ltd., Publishers - 2000.
- M. N. Bandopadhay, Control Engineering - Theory &Practice, PHI, 2003

Prepared by Checked by Head of the Department Principal

Program: Mechanical Engineering	T.Y B. Tech.	Semester: VI
Course: Quality Engineering (DJS22MEC6011)		
Course: Quality Engineering Laboratory (DJS22MEL6011)		

Pre-requisite: --

1. Knowledge of Probability and Statistics.
2. Knowledge of MS Excel, Mini Tab basics

Objectives:

1. Understand basic quality management principles.
2. Understand the relationship of the quality engineer to the quality system.
3. Analyse the relationship of statistics to a process.
4. Understand process capability and use statistical process control to monitor a process.
5. Generate acceptance sampling plans and identify and use technical quality tools.
6. Apply problem-solving tools and basic statistical concepts, process control and process capability plans, acceptance sampling, and attribute controls

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

1. Understand the importance of Quality for survival and growth of any business.
2. Understand and apply the different control charts for quality improvement.
3. Evaluate Process capability and determine tolerance limits for different process.
4. Apply ANOVA test and decide the degree of relation between independent variables.
5. Understand the significance of quality and application of Six Sigma in service sector.

Quality Engineering (DJS22MEC6011)		
Unit	**Description**	**Duration**
1	**Introduction:** Different Definitions and Dimensions of Quality, Historical Perspective, Contribution of Renowned Quality Gurus, Total Quality Management Basic Philosophy, Approach, Barriers. Mindset of Quality Improvements: High quality of product and service and their associated customer satisfaction are the key to the survival and growth for any enterprises. Management culture advocating a total commitment to customer satisfaction through continuous improvement and innovation in all aspects of the business must be discussed in detail.	**06**
2	Introduction to Control charts, construction, and application. Chance and assignable causes of process variation, Statistical basis of the control chart for variable, Attribute control charts -p, n np, c, and u charts.	**09**
3	Acceptance Sampling Fundamental, QC Curves, Sampling Plans for Attributes, Signal and double sampling plans, Multiple and Sequential sampling plans, sampling plans for variables Demo on use of software like MS Excel, Minitab and JMP for control charts and acceptance sampling.	**06**

4	**Introduction to Design of Experiments:** Introduction, Methods, Taguchi approach, achieving robust design, Steps in experimental design. Introduction to ANOVA, Need for ANOVA, NO-way ANOVA, One-way ANOVA, Two-way ANOVA, ANOVA for four level factors, multiple level factors. Introduction to t-test, f-test and hypothesis in connection with ANOVA. **Demo on use of software like MS Excel, Minitab and JMP for DOE.**	**12**
5	**Quality in Service Sectors:** Characteristics of Service Sectors, Quality Dimensions in Service Sectors, Measuring Quality in Different Service Sectors, Six sigma DMAIC methodology, and tools for process improvement, six sigma in services and small organizations, statistical foundations, statistical methodology.	**06**
	Total	**39**

Quality Engineering Laboratory (DJS22MEL6011)	
Exp. No.	**Suggested experiments**
	Case studies on Statistical Process Control
1	**Control Charts for Variable Data** (Plotting of X bar and R chart and evaluation of process capability)
2	**Control Charts for Attribute Data** (Plotting of p- chart, np-chart, u-chart, and c- chart)
	Case studies on Design of Experiments
3	**Single-factor experiment** (In single factor experiments only one factor is investigated)
4	**Multi-factor factorial experiment** (In factorial experiments, combination of two or more levels of more than one factor is the treatment)
5	**The 2^k Factorial Experiments** (A factorial design with k-factors, each at only two levels is called 2^k design, a special case of multi-factor factorial experiment)
6	**Design of experiments using orthogonal array** Data collected from Taguchi/Orthogonal Array (OA) experiments can be analysed using response graph method or Analysis of Variance (ANOVA)
7	**Robust design** (experiments can be analysed using S/N RATIOS)

In term work all experiments as listed above or any other experiment based on syllabus will be included, which would help the learner to apply the concept learnt. All case studies shall be solved using available software tools (MS Excel, Minitab, JMP (statistical software), etc.) and concluded.

Books Recommended:

Textbooks:

- D. C. Montgomery; Introduction to Statistical Quality Control; Edition 6; 2009; John Wiley & Sons
- Tapan P. Bagchi; Taguchi Methods explained: Practical steps to Robust Design; 1993; Prentice Hall Pvt. Ltd., New Delhi.
- N. Logothetis; Managing for Total Quality; 1997; Prentice Hall of India
- K. Krishnaiah; Applied Design of Experiments and Taguchi Methods; 2012; Prentice Hall of India

Reference Books:

- Grant and Leavenworth; Statistical Quality Control; 1996; McGraw-Hill
- R.E. Devor, T. Chang; J.W. Sutherland, Statistical Quality Design and Control; 2007;
- Prentice Hall
- D.A. Garvin; Managing Quality; 1988; Free Press
- G. Taguchi; Introduction to Quality Engineering; 1986; Asian productivity organisation
- H.J. Harrington; Poor Quality Cost; 1987; Tayler and Francis
- M.S. Phadke; Quality Engineering Using Robust Design; 1989; Prentice Hall

Program: Mechanical Engineering	T.Y. B.Tech	Semester: VI
Course: Vehicle Dynamics and NVH (DJS22MEC6012)		
Course: Vehicle Dynamics and NVH Laboratory (DJS22MEL6012)		

Pre-requisites:

1. Manufacturing processes, mechanics of materials
2. Mechanical vibrations
3. Automotive systems

Objectives:

1. To analyse the behaviour of vehicles under different dynamic conditions.
2. To impart the knowledge of automotive noise and vibration sources and their measurement techniques.

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

1. Apply the knowledge of automotive systems and analyse the vehicle dynamic performance.
2. Evaluate the tyre forces during the vehicle acceleration and braking dynamics.
3. Analyse the steering & suspension systems and their influence on vehicle handling
4. Identify and analyse the sources of noise and vibration in automotive applications.

Vehicle Dynamics and NVH (DJS22MEC6012)		
Unit	**Description**	**Duration**
1	Introduction to vehicle dynamics - Dynamics of the motor vehicle, Vehicle fixed coordinates system, Earth fixed coordinates system, Details of vehicle systems, wheel angles and Typical data of vehicles. **Forward Vehicle Dynamics:** Resistance to the Motion of Vehicle, Road Performance curve, Resistances at various vehicle speeds, Traction and Tractive effort, Acceleration, power required for propulsion of vehicle, gear ratio for maximum acceleration. Analysis of parked car on a level road, parked car on an inclined road, accelerating car on a level road, accelerating car on an inclined road, Parked car on a banked road, Vehicles on crest and rip.	**08**
2	**Longitudinal dynamics:** Forces and moments on vehicle, Equation of motion, Tire forces, rolling resistance, weight distribution, Tractive effort and Power available from the engine, Evaluation of maximum acceleration, braking torque, braking force, brake proportioning, braking efficiency, stopping distance, prediction of vehicle performance.	**07**
3	**Lateral Dynamics**: Steering geometry, Types of steering systems, Fundamental condition for true Rolling, Evaluation of lateral forces. Steady state handling characteristics. Yaw velocity, Lateral Acceleration, Curvature response & directional stability.	**07**
4	**Vertical Dynamics**: Sources of Vibration, Suspension systems, Functions of suspension system. Body vibrations: Bouncing and pitching riding comfort, vibration transmission to the passengers; Analysis of vehicle suspension models.	**07**

5	**Noise, Vibration & Harshness:** Introduction to types of automotive noises, noise propagation, measurement, Noise limits for vehicles, Acoustic source characteristics of I.C. Engines, Mufflers, Noise control strategies, estimation and control of noise of prime movers.	**05**
6	Vibration and its measurement, vibration control, vibration isolators, passive and active engine mounts, crankshaft damping, active vibration control.	**05**
	Total	**39**

Vehicle Dynamics and NVH Laboratory (DJS22MEL6012)	
Exp.	**Suggested experiments**
1	Numerical investigation of different vehicle resistances on flat and inclined roads
2	Simulation of different vehicle resistances on flat and inclined roads on MATLAB Simulink
3	Experimental determination of damping coefficient of any system
4	Simulation of steering / suspension system using Adams / Solidworks software / any other software
5	Stress analysis of ladder frame chassis on ANSYS / Solidworks under different loading conditions
6	Investigation of vibration in light motor vehicle in dynamic conditions
7	Case study on noise control strategies deployed in the automotive industry

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.

Books Recommended:

Text books:

- Bruce P. Minaker, Fundamentals of Vehicle Dynamics and Modelling, 2019, John Wiley & Sons
- Martin Meywerk, Vehicle Dynamics, 2015, Wiley
- M L Munjal, Noise and vibration control, 2013, IISC Press

Reference Books:

- Thomas D. Gillespie, Fundamentals of Vehicle Dynamics, 2021, SAE International
- Rajesh Rajamani, Vehicle Dynamics and Control, 2012, Springer US

Program: Mechanical Engineering	T.Y. B.Tech	Semester: VI
Course: Mechanical Vibrations (DJS22MEC6013)		
Course: Mechanical Vibrations Laboratory (DJS22MEL6013)		

Pre-requisite: --

1. Engineering Mechanics
2. Differentiation, Integration and Matrix Operations
3. Dynamics of Machinery

Objectives:

1. To formulate the equations of motion of multi degree-of-freedom systems
2. To find the natural frequencies of vibration and the modal shapes of multi degree-of-freedom systems
3. To develop response equations for undamped system under support excitation, rotary unbalance and reciprocating unbalance
4. To analyze the effects of vibration for systems with vibrating base.
5. To evaluate the various aspects of machine-condition monitoring
6. To develop the applications of vibration absorbers.

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

1. Analyze systems with multi degree of freedom system
2. Evaluate response of undamped systems under support excitation, rotary unbalance and reciprocating unbalance
3. Create a vibration and shock isolations system for systems with vibrating base
4. Analyze various aspects of machine-condition monitoring
5. Develop systems with undamped and damped vibration absorbers to control vibrations in machines and structures.

Mechanical Vibrations (DJS22MEC6013)		
Unit	**Description**	**Duration**
1	**Basic Concepts of Vibration:** Introduction, Free and Forced Vibrations, Damped and Un-damped Vibrations, Degree of Freedom **Two-Degree-of-Freedom Systems:** Introduction, Mode Shapes, Free Vibration Analysis of an Un damped Systems – Translational and Torsional, using Newton's second law, and Lagrange s Equations	**6**
2	**Multi Degree of Freedom System (more than 2 DOF):** Introduction, Mode Shapes, Determination of Natural Frequencies, Modelling of Continuous Systems as Multi degree of-Freedom Systems, Using Newton s Second Law to Derive Equations of Motion, Influence Coefficients, Equations of Motion of Un damped Systems in Matrix Form, Eigenvalue Problem, Solution of the Eigenvalue Problem (Undamped and Free Vibrations systems only), Dunkerley's Formula, Rayleigh's Method, and Holzer's Method	**10**
3	**Forced Vibrations:** Analysis of Forced Vibration System systems under support excitation, rotary unbalance and reciprocating unbalance.	**5**

4	**Machine Condition Monitoring and Diagnosis:** Vibration Severity Criteria, Machine Maintenance Techniques, Machine Condition Monitoring Techniques, Vibration Monitoring Techniques, Instrumentation Systems, Choice of Monitoring Parameter	**6**
5	**Vibration Isolation**: Vibration Isolation System with Flexible Foundation, Vibration Isolation System with Partially Flexible Foundation, Shock Isolation, Active Vibration Control	**6**
6	**Vibration Absorbers:** Undamped Dynamic Vibration Absorber, Damped Dynamic Vibration Absorber	**6**
	Total	**39**

Mechanical Vibrations Laboratory (DJS22MEL6013)	
Exp.	**Suggested experiments**
1	Modal Analysis of Impact Test on cantilever
2	Sine Sweep of base excitation of cantilever
3	Find MI of irregularly shaped solid body using tri-filar suspension
4	Analysis of System with Single Degree under Arbitrary Excitation
5	Analyse Working of Tuned Vibration Absorber
6	Evaluation of Effects of Base Excitation
7	Analyse the Effects of Rotating Unbalance
8	Simulate System with Two Degree of Freedom under Forced vibration
9	Study the Working of Dynamic Vibration Absorber
10	Evaluate the Effects of Mechanical Looseness
11	Analyse Sympathetic Vibrations and evaluate its Effects
11	Simulation of FFT Analyzer using MATLAB
12	Vibration Analysis using MATLAB – SIMULINK

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:

Text books:

- S.S.Rao, Mechanical Vibrations, Pearson Education, 6th edition 2018
- G. K. Grover, Mechanical Vibraitons, Nem Chand & Bros, 2009
- S.Graham Kelly, Fundamentals of Mechanical Vibration, Tata McGraw Hill, Edition. 2nd, 2000
- P. Srineevasan, Vibration Analysis, Tata McGraw Hill, 1982
- William W.Seto, Mechanical Vibrations- Schaum's outline series, McGraw Hill, 1964

- J.S.Rao, K. Gupta, Theory and Practice of Mechanical Vibrations, New Age International Publications, Second Edition, 1999

Reference Books:

- Leonard Meirovitch, Elements of Vibration Analysis, McGraw - Hill, New York, 1986
- Antony J. Pettofrezzo, Matrices and Transformations, Dover, New York, 1978
- Benson H. Tongue, Principles of Vibration, Oxford University Press, 2001
- W. Thomson, Theory of Vibration with Applications, Pearson Education, 2008
- Balakumar Balachandan, Edward Magrab, Vibrations, Cengagae Learning, 2008

Program: Mechanical Engineering	T.Y B. Tech	Semester: VI
Course: Refrigeration and Air-Conditioning (DJS22MEC6014)		
Course: Refrigeration and Air-Conditioning Laboratory (DJS22MEL6014)		

Pre-requisites:

1. Thermodynamics
2. Heat transfer

Objectives:

1. To discuss the principles of refrigeration and air-conditioning systems.
2. To analyse and compare the performance of different refrigeration and air-conditioning systems.
3. To discuss the controls and applications of refrigeration and air-conditioning systems.

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

1. Apply the fundamentals of refrigeration cycles and calculate the coefficient of performance of air refrigeration systems.
2. Describe the working of vapour compression refrigeration systems and analyse their performance.
3. Apply the principles of psychromteric properties and processes to air-conditioning systems.
4. Design air-conditioning systems using cooling load calculations and duct design principles.
5. Examine the role of sensors & controls techniques used in modern HVAC systems.

Refrigeration and Air-Conditioning (DJS22MEC6014)		
Unit	**Description**	**Duration**
1	**Introduction to Refrigeration:** First and Second Law applied to refrigerating machines, Carnot refrigerator & heat pump. Unit of refrigeration, Energy Efficiency Ratio (EER) and BEE star rating. Air refrigeration systems: Bell Coleman cycle, analysis and applications. Aircraft refrigeration systems: Simple, Bootstrap, Reduced ambient & Regenerative aircraft cooling system, Importance of Dry Air Rated Temperature.	**06**
2	**Vapour Compression Refrigeration Systems:** Analysis of simple vapour compression cycle, effect of liquid sub cooling & superheating, effect of evaporator and condenser pressures, methods of sub-cooling, Use of P-h charts, Actual VCR cycle, Analysis of 2 stage VCR systems & its applications. **Refrigerants:** Desirable properties of refrigerants, ASHRAE numbering system for refrigerants, Secondary refrigerants, ODP and GWP, Montreal & Kyoto protocol and India's commitment & Recent developments in refrigerants. **Non-Conventional Refrigeration Systems:** Thermoelectric refrigeration, Thermo-acoustic refrigeration, Vortex tube refrigeration systems & Radiant heating and cooling systems.	**09**
3	**Psychrometry:** Need for air conditioning, Principle of psychromerty, Psychrometric properties, chart and processes, Bypass factor, Sensible heat factor, Adiabatic mixing of two air streams,	**05**

	Air washers, Requirements of comfort air conditioning, Summer and Winter Air conditioning.	
4	**Design of Air Conditioning Systems:** Different Heat sources, Cooling Load estimation, Ventilation and infiltration, Inside and Outside Design condition, Room apparatus dew point and coil apparatus dew point temperature, RSHF, GSHF, ERSHF. Human Comfort, Thermal exchange of body with environment, Effective temperature, Comfort chart, Comfort zone, Indoor Air Quality, Green Buildings. Sustainable techniques.	**09**
5	**Duct Design:** Introduction to ducts, types of ducts, air flow in a duct, Equivalent diameter of a circular duct for rectangular ducts, Methods of duct design, Factors considered in air distribution system, Air distribution systems for cooling and heating. Air Handling: Fan coil unit, Types of fans used air conditioning applications, Fan laws, supply and return grills.	**06**
6	**Components:** Filters, Compressors, Condensers, Expansion devices and Evaporators. Room/Split and Packaged Air Conditioners, VRF systems, VAV systems, Inverter Units. Cooling towers, types, tower approach, tower range, tower efficiency, tower losses and tower maintenance. **Controls:** Digital controls, Control strategies, Electronic Controllers, LP/HP cut-off. Sensors: Temperature sensor, Humidity sensor, IAQ sensors, IoT in HVAC industry.	**04**
	Total	**39**

Refrigeration and Air-Conditioning Laboratory (DJS22MEL6014)	
Exp.	**Suggested experiments**
1	Comparison and analysis of different refrigerator systems along with troubleshooting.
2	Research on leak detection, evacuation methods and charging of refrigerant.
3	Report on different refrigerant protocols to regulate global warming.
4	Experimental analysis of refrigeration test rig performance parameters.
5	Experimental analysis of an air conditioning test rig performance parameters.
6	Steady state simulation of VCR system with an analytical software.
7	Cooling load estimation exercise for an actual room/auditorium.
8	Visit report of a manufacturing unit of refrigerator/air-conditioner or a cold storage plant/ice plant.
9	Report on IoT implantation in HVAC industry.

Minimum seven 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:

Text books:

- C P Arora, Refrigeration and air-conditioning, 2018, TMH
- Domkundwar, Arora, Refrigeration and air-conditioning, 2017, Dhanpat Rai
- P.Ananthanarayana, Basic Refrigeration and air-conditioning, 2016, TMH

Reference Books:

- R J Dossat, Principles of refrigeration, 2002, Willey Eastern Publication
- Roger Legg, Air Conditioning System Design, 2017, BH
- ASHRAE Handbook of Fundamentals
- ISHRAE Refrigeration Handbook
- ISHRAE Air Conditioning Handbook

Program: Mechanical Engineering	**T.Y. B.Tech**	**Semester: VI**
Course: Machine Learning (DJS22MEC6015)		
Course: Machine Learning Laboratory (DJS22MEL6015)		

Pre-requisite: --

1. Linear Algebra, Probability, Statistics, Logical Reasoning.
2. Fundamentals of Mechanical Engineering

Objectives:

1. Acquaint with fundamentals of artificial intelligence and machine learning.
2. Learn feature extraction and selection techniques for processing data sets.
3. Understand basic algorithms used in classification and regression problems.
4. Outline the steps involved in the development of the machine learning model.
5. Familiarize with concepts of reinforced and deep learning.
6. Implement and analyze machine learning models in mechanical engineering problems.

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

1. Apply the fundamentals of artificial intelligence and machine learning.
2. Apply feature extraction and selection techniques.
3. Apply machine learning algorithms for classification and regression problems.
4. Devise and develop a machine learning model using various steps.
5. Apply the concepts of reinforced and deep learning to solve mechanical engineering problem.
6. Simulate machine learning model in mechanical engineering problems.

Machine Learning (DJS22MEC6015)		
Unit	**Description**	**Duration**
1	**Introduction to AI-ML** History of AI, Comparison of AI with Data science, Need of AI-ML-DL in Mechanical Engineering, Introduction to Machine Learning. Basics: Reasoning, problem solving, Knowledge representation, Planning, Learning, Perception, Motion and manipulation. **Approaches to AI:** Cybernetics and brain simulation, Symbolic, Sub-symbolic, Statistical. **Approaches to ML:** Supervised learning, Unsupervised learning, Reinforcement learning.	**6**
2	**Feature Extraction and Selection** **Feature extraction:** Statistical features, Principal Component Analysis. **Feature selection:** Ranking, Decision tree - Entropy reduction and information gain, Exhaustive, best first, Greedy forward & backward, Applications of feature extraction and selection algorithms in Mechanical Engineering.	**6**
3	**Classification and Regression Models** **Classification Models -** Random Forest, Logistic regression, decision tree, Support Vector Regression, K-Nearest Neighbor (KNN), K-Means, Naive Bayes. **Regression Models -** Linear and non-linear regression, neural network regression, overfitting and underfitting. Applications of classification models in Mechanical Engineering.	**8**

4	**Development of ML Model** Problem identification: classification, clustering, regression, ranking. Steps in ML modeling, Data Collection, Data pre-processing, Model Selection, Model training (Training, Testing, K-fold Cross Validation), Model evaluation (understanding and interpretation of confusion matrix, Accuracy, Precision, Recall, True positive, false positive, etc.), Hyperparameter Tuning, Predictions.	**7**
5	**Reinforced and Deep Learning** What is reinforcement learning? Terms used; Key features; Working process; Approaches – value-based, policy-based, and model-based; Elements – policy, reward signal, value function, model of the environment; The Bellman equation; Types – positive and negative; RL algorithms; Q-learning; Comparison between RL and supervised learning. Characteristics of Deep Learning, Artificial Neural Network, Convolution Neural Network.	**7**
6	**Applications** Applications should be related to the following 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	**5**
	Total	**39**

Note – Numerical should be related to mechanical and allied engineering domains.

Machine Learning Laboratory (DJS22MEL6015)	
Exp.	**Suggested experiments**
Group A: Any five experiments from the following list for a data set using a suitable software package/ programming language	
1	To study supervised, unsupervised, and reinforcement learning approach: Explore applications of these learning methods to analyze mechanical systems, control processes, or material behavior.
2	To acquire, visualize and analyze the data set (from time-domain/ frequency-domain/ etc.): Work with data sets from time-domain, frequency-domain, or strain gauges, vibration analysis, or thermal data from mechanical systems.
3	To extract features from given data set and establish training data: Extract relevant features from datasets obtained from sensors, strain gauges, or operational data of mechanical systems, and prepare it for machine learning.
4	To select relevant features using suitable technique: Use suitable techniques (e.g., statistical tests, mutual information) to select relevant features for analysis in mechanical performance prediction or failure analysis.
5	To use PCA for dimensionality reduction: Apply PCA to reduce the number of features in complex mechanical data sets, like vibration signatures or temperature-time histories, while retaining critical information.
6	To classify features/ To develop classification model and evaluate its performance (any one classifier): Develop a classification model (e.g., SVM, decision trees) to categorize

	mechanical system behavior (e.g., fault detection or material property prediction) and evaluate its performance.
7	To develop regression model and evaluate its performance (any one algorithm): Build a regression model (e.g., linear regression, random forest) to predict continuous mechanical system parameters (e.g., stress, strain, or failure times) and evaluate its performance.
8	Markov process for modelling manufacturing processes: Apply Markov processes to model manufacturing processes, such as assembly lines or material flow in production systems, considering states and transitions of various process stages.
9	Reinforced Learning for optimizing engineering designs / Robot Guidance and Navigation: Use reinforcement learning to optimize engineering design processes (e.g., material selection or structural design) or for robot guidance and navigation in manufacturing and assembly environments.
10	GA for optimization of multi-dimensional function / path planning in robotics: Apply GA to optimize multi-dimensional functions in mechanical design (e.g., shape optimization of components) or path planning in robotics.
11	NN for parameter and model identification / tuning of Control Algorithms: Utilize neural networks to identify system parameters or tune control algorithms in mechanical systems (e.g., thermal control systems, robotic arms).
Group B (Mandatory) One mini project (in a group of 3-4 students) based on the above contents and using mechanical engineering application dataset.	

Books Recommended:

Text books:

- M. P. Deisenroth, A. A. Faisal, C. S. Ong, Mathematics for Machine Learning, Cambridge University Press, 2020.
- B. Joshi, Machine Learning and Artificial Intelligence, Springer, 2020.
- Parag Kulkarni and Prachi Joshi, "Artificial Intelligence – Building Intelligent Systems," PHI learning Pvt. Ltd., ISBN – 978-81-203-5046-5, 2015.
- Stuart Russell and Peter Norvig (1995), "Artificial Intelligence: A Modern Approach," Third edition, Pearson, 2003.

Reference Books:

- Solanki, Kumar, Nayyar, Emerging Trends and Applications of Machine Learning, IGI Global, 2018.
- Mohri, Rostamizdeh, Talwalkar, Foundations of Machine Learning, MIT Press, 2018.
- Kumar, Zindani, Davim, Artificial Intelligence in Mechanical and Industrial Engineering, CRC Press, 2021.
- Zsolt Nagy, Artificial Intelligence and Machine Learning Fundamentals-Apress (2018)
- Elaine Rich, and Kevin Knight, Artificial Intelligence, TATA McGraw Hill, 1991.

Web References:

- An Introduction to AI (https://archive.nptel.ac.in/content/syllabus_pdf/106102220.pdf)
- Fundamentals of Artificial Intelligence (https://nptel.ac.in/courses/112103280)
- Machine Learning (https://nptel.ac.in/courses/106/106/106106202/)
- Introduction to Machine Learning (https://nptel.ac.in/courses/106106139)
- Deep Learning (https://padhai.onefourthlabs.in/courses/dl-feb-2019)

Prepared by Checked by Head of the Department Principal

Program: Mechanical Engineering	T.Y. B.Tech	Semester: VI
Course: Fundamentals of Business Development (DJS22MEC6016)		
Course: Fundamentals of Business Development Laboratory (DJS22MEL6016)		

Pre-requisite:

1. Incubation, Entrepreneurship and Startups

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.
6. Gain a solid understanding of financial modelling principles and key metrics, enabling informed decision-making for business growth.

Outcomes: Upon successful completion of the course, learners 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.
6. Apply a solid understanding of financial modelling principles and key metrics to make informed decisions driving business growth.

Fundamentals of Business Development (DJS22MEC6016)		
Unit	**Description**	**Duration**
1	**Strategic Business Planning** • Fundamentals of Strategic Planning • Market Trends and Competitive Analysis • Formulating Business Strategies • 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 • Role-Playing Exercises on Sales and Negotiation	**6**
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	**6**
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	**6**
6	**Innovation and Adaptation** • Innovative Approaches to Business Development • Adaptive Strategies for Changing Business Environments • Case Studies on Business Innovation • Innovation Challenges and Solutions • Final Project: Innovative Business Plan Presentation • Course Review and Reflection	**5**
		39

Fundamentals of Business Development Laboratory (DJS22MEL6016)	
Sr. No.	**Exercises**
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 experiment based on syllabus will 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:

- Covey, Stephen R. The 7 Habits of Highly Effective People. Free Press, 1989.
- David, Fred R. Strategic Management: Concepts and Cases. Pearson Education, 17th Edition, 2017.
- Drucker, Peter F. The Effective Executive. Harper Business, 1967.
- Kaufman, Josh. The Personal MBA. Penguin Books, 2010.
- Koontz, Harold, and Heinz Weihrich. Principles of Management. McGraw-Hill Education, 10th Edition, 1988.
- Lawrence, Anne T., and James Weber. Business and Society: Stakeholders, Ethics, Public Policy. McGraw-Hill Education, 15th Edition, 2016.
- Porter, Michael E. Competitive Strategy: Techniques for Analyzing Industries and Competitors. Free Press, 1980.
- Pride, William M., Robert J. Hughes, and Jack R. Kapoor. Foundations of Business. Cengage Learning, 6th Edition, 2020.
- Ries, Eric. The Lean Startup. Crown Business, 2011.
- Robbins, Stephen P., and Timothy A. Judge. Organizational Behavior. Pearson Education, 13th Edition, 2009.
- Ross, Stephen, Randolph Westerfield, and Jeffrey Jaffe. Corporate Finance: Core Principles and Applications. McGraw-Hill Education, 5th Edition, 2019.
- Thiel, Peter, and Blake Masters. Zero to One. Crown Business, 2014.
- Besanko, David, David Dranove, Mark Shanley, and Scott Schaefer. Economics of Strategy. Wiley, 6th Edition, 2012.

Program: Mechanical Engineering	T.Y. B.Tech	Semester: VI
Course: Creative Engineering Design (DJS22MEC6017)		
Course: Creative Engineering Design Laboratory (DJS22MEL6017)		

Pre-requisite: --

1. No prerequisites required. However, the knowledge of the fundamentals of mechanical engineering can have an advantage.

Objectives:

1. To understand the importance of identifying and analyzing customer requirements in the product design and development process.
2. To learn techniques for gathering, prioritizing, and interpreting customer needs and preferences.
3. To develop skills in problem definition and ideation, enabling students to creatively generate solutions to identified problems.
4. To explore methods for generating and evaluating design concepts, with an emphasis on feasibility, desirability, and viability.
5. To gain proficiency in translating selected concepts into detailed designs through embodiment design, considering materials, manufacturing processes, and assembly methods.
6. To familiarize students with prototyping techniques and tools for validating design concepts and uncovering potential issues.

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

1. Identify and analyze customer requirements to inform the design process effectively.
2. Apply problem definition and ideation techniques to generate innovative solutions to real-world problems.
3. Evaluate and select design concepts based on feasibility, desirability, and viability criteria.
4. Develop detailed designs considering materials, manufacturing processes, and assembly methods.
5. Apply the design principles to create prototypes using appropriate tools and techniques to validate design concepts.
6. Test and evaluate prototypes to ensure they meet design requirements and user needs.

Creative Engineering Design (DJS22MEC5017)		
Unit	**Description**	**Duration**
1	**Customer Requirements** • Importance of identifying and analyzing customer needs and preferences. • Types of customer requirements: functional, performance, usability, reliability, safety, regulatory and compliance, environmental, cost and price, aesthetics and ergonomics. • Steps involved in the gathering of the raw data from the customers. • Gathering customer requirements: surveys, interviews, focus groups, observations, customer feedback, market research, etc. • Techniques to prioritize customer requirements: Pareto analysis, Importance-Performance Analysis (IPA), Kano model, Analytic Hierarchy Process (AHP), Decision matrix, etc. • Case studies on deep understanding customer requirements.	**7**

2	**Problem Definition (Ideation)** • The role of clear defining and framing the problem in the design process. • What are product specifications? When are the specifications established? • Steps involved in establishing target specification. • Ideation techniques for generating creative solutions to identified problems, such as brainstorming, mind mapping, and SCAMPER (Substitute, Combine, Adapt, Modify/ minimize/ Magnify, put to another use, Eliminate, Reverse/ Reorder). • Setting the final specifications. • Case studies on converting the customer requirements into product specifications.	**7**
3	**Concept Generation and Selection** • Concept generation and selection phase in the product design and development. • Creativity and innovation in novel concept generation. • The activities and methods involved in the concept generation and selection. • Criteria and considerations for evaluating and selecting design concepts: feasibility, desirability, viability, and alignment with user needs and business goals. • Concept testing: iterative refinement and feedback; decision making and communication • Case studies on the concept generation and selection.	**7**
4	**Detailed Design/Embodiment Design** • Detailed design phases. • Translating selected concepts into detailed designs through embodiment design. • Materials and manufacturing processes: selection based on the availability, properties, cost and manufacturability, Design For Manufacturability and Assembly (DFMA) • Computer-Aided Design (CAD) modeling and technical drawing, parametric modeling, feature-based modeling, and assembly modeling. • Design for reliability and maintainability. • Modular design, standardization, and component reuse. • Considerations for minimizing part count, simplifying assembly processes, and improving maintenance accessibility.	**6**
5	**Prototyping** • Importance of prototyping in design validation and uncovering potential issues. • Types of prototypes: low-fidelity, medium-fidelity, and high-fidelity prototypes. • Principles of prototyping: cost of comprehensive prototype (time or money). • Dimensions of prototyping: Physical, analytical, focused, and comprehensive. • Prototyping technologies such as 3D printing, CNC machining, laser cutting, and rapid prototyping. • Planning for prototypes	**6**

	• Case studies on prototyping	
6	**Testing and Validation for Design Solution** • Importance of testing for verifying design solutions, uncovering issues, and ensuring product quality and reliability. • Testing and validation phases in product design and development. • Types of testing: usability, functional, performance, reliability, and environment testing. • Laboratory vs. field testing. • Prototyping and simulation testing, and validation: FEA, CFD, tolerance analysis, • Optimization for cost, size, reliability, etc. • Compliance and regulatory testing. • Iterative refinement based on feedback gathered during testing and validation.	**6**
	Total	**39**

Creative Engineering Design Laboratory (DJS22MEL6017)	
Exp.	**Suggested Experiments/ Exercises/ Assignments/ Activities/ Discussions/ Case studies**
1	Customer requirements analysis: A case study.
2	Customer need/ requirements prioritization exercise.
3	Mock customer feedback session.
4	Problem framing and ideation.
5	Establishing target specifications exercise.
6	Creative design challenge.
7	Concept Selection Simulation.
8	Prototype Comparison and Evaluation.
9	Prototyping Case Study Analysis.
10	Study on the usability testing and iterative refinement.
11	Compliance Testing and Regulatory Compliance.

A minimum of six experiments/ exercises/ assignments/ activities/ discussions/ case studies from the above-suggested list or any other experiment/exercise based on the syllabus will be included, which would help the learner to apply the concept learned.

Books Recommended:

Textbooks:

- Karl T. Ulrich and Steven D. Eppinger, Product Design and Development, McGraw Hill Education, 6th Edition, 2016.
- C. Charyton, Creative Engineering Design Assessment: Background, Directions, Manual, Scoring Guide, and Uses, Springer London, 2013.

Reference Books:

- A. Chakrabarti, Engineering Design Synthesis: Understanding, Approaches and Tools, Springer, 2002.
- K. Otto, and K. Wood, Product Design, Prentice Hall, 2000.
- T. Taura, Creative Design Engineering: Introduction to an Interdisciplinary Approach, Elsevier Science, 2016.

Web References:

- Creative Engineering Design (https://nptel.ac.in/courses/107108010)
- Understanding Creativity and Creative Writing (https://nptel.ac.in/courses/109101017)

Program: Mechanical Engineering	T.Y B.Tech	Semester: VI
Course: Mechatronics (DJS22MEC6018)		
Course: Mechatronics Laboratory (DJS22MEL6018)		

Pre-requisite: --

1. Basic knowledge of Motors and actuators
2. Basic knowledge of controls

Objectives:

1. To study key elements of the Mechatronics system and its integration.
2. To familiarize concepts of sensor characterization and its interfacing with microcontrollers.
3. To Design Pneumatic and Hydraulic Circuits for Industrial purposes.

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

1. Represent the Mechatronics system with block diagrams.
2. Identify the suitable sensors and actuators for a given mechatronics system.
3. Distinguish and analyse various circuits for signal conditioning and their interfacing with microcontrollers.
4. Design hydraulic/pneumatic circuits for industrial applications.
5. Familiarize with the modern trends of Automation.

Mechatronics (DJS22MEC6018)		
Unit	**Description**	**Duration**
1	**Introduction of Mechatronics and automation:** Key elements of mechatronics and automation, Applications of Mechatronics domestic, industrial etc. Levels of automation Automation principles and strategies: ten strategies of automation and production system, automation migration strategy Advanced automation functions: safety, maintenance & repair diagnosis, error detection and recovery	**06**
2	**Sensors and actuators:** Criteria for selection of sensors based on requirements, principle of measurement, sensing method, performance chart etc. (Displacement, temperature, acceleration, force/pressure) based on static and dynamic characteristics. Actuators: Selection of actuators based on principle of operation, performance characteristics, maximum loading conditions, safety etc. Selection process of mechano-electrical actuators (1) DC motors (2) Stepper Motors (3) Solenoid Actuators (4) Servo Motors (5) BLDC	**07**
3	**Mechanization, Automation and Interfacing:** Mechanization and automation, product cycle, hard Vs flexible automation, Capital-intensive Vs low-cost automation Types of systems-mechanical, electrical, hydraulic, pneumatic and hybrid systems Automation using CAMS, Geneva mechanisms, gears etc. Assembly line Automation: automated assembly systems, transfer systems, vibratory bowl feeders, non-vibratory feeders, part orienting, feed track, part placing & part escapement systems Introduction to Material storage/ handling and transport systems, and its automation using AS/RS, AGVS and conveyors etc. Interfacing: Interfacing of 8051 with Different types of Motors	**07**

4	**Industrial Circuits:** Pneumatic and hydraulic devices-Different types of valves, Actuators and auxiliary elements in Pneumatics & hydraulics, their applications and use of their ISO symbols Synthesis and design of circuits (up to 3 cylinders)–pneumatic, electro pneumatics and hydraulics Design of Electro-Pneumatic Circuits using single solenoid and double solenoid valves; with and without grouping	**12**
5	**Introduction to Robotics**: Introduction to Robotics, IoT and Artificial Intelligence: Automation and Robotics, Robot types, anatomy and related attributes, accuracy, repeatability Trajectory planning, Robot control system and end effector, Sensors in robotics, Industrial application and future applications, Introduction to IoT Introduction to Artificial Intelligence.	**07**
	Total	**39**

Mechatronics Laboratory (DJS22MEL6018)	
Exp.	**Suggested experiments**
1	Interfacing of different types of Sensors
2	Interfacing of different types of Actuators
3	Developing Automatic Systems *
4	Developing Automatics /Control systems *
5	Report on comparison between traditional manufacturing and Automated manufacturing with a case study.

* The Automatic / control systems can be generated using Electro-pneumatic/ electro Hydraulic / Pneumatic or Hydraulic circuit sequencing. The circuits must be analyzed and verified onto FluidSim Software before they get performed onto the Equipment. Minimum of 2 different sequential circuits on each category as mentioned above.

Books Recommended:

- Ahmad Smaili and Fouad Mrad, Applied Mechatronics, Oxford University Press, ISBN: 9780195307023, 2008.
- Godfrey Onwubolu, Mechatronics Principles and Applications, Butterworth-Heinemann, ISBN: 9780080492902, 2005.
- Aydin Azizi, Emerging Trends in Mechatronics, IntechOpen, ISBN: 9781789843194, 2020.
- William Bolton, Mechatronics: Electronic Control Systems in Mechanical and Electrical Engineering, Pearson Education Limited, ISBN: 9781292250977, 2019.
- William Bolton, Mechatronics, Pearson, ISBN: 9781292250991, 2018.
- Sergey Edward Lyshevski, Mechatronics and Control of Electromechanical Systems, CRC Press, ISBN: 9781351651462, 2017.
- Bogdan M. Wilamowski and J. David Irwin, Control and Mechatronics, CRC Press, 2011.

Prepared by Checked by Head of the Department Principal

Program: Mechanical Engineering	T.Y B.Tech	Semester: VI
Course: Professional and Business Communication Laboratory (DJS22IHL)		

Pre-requisite: --

1. Basic course in Effective Communication Skills

Objectives:

1. To inculcate professional and ethical attitude at the workplace
2. To enhance communication and interpersonal skills
3. To develop effective employability skills
4. To hone written skills for technical documentation

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

1. Prepare technical documents using appropriate style, format, and language
2. Use employability skills to optimize career opportunities
3. Employ storytelling techniques in corporate situations
4. Conduct effective meetings and document the process
5. Demonstrate interpersonal skills in professional and personal situations
6. Describe cultural differences, etiquettes, and the concept of professional ethics

Professional and Business Communication Laboratory (DJS22IHL)		
Unit	**Description**	**Duration**
	Unit 1: Technical Writing	
1	**Report Writing:** Types of reports, Basic structure of a report, collection of data through questionnaires, survey analysis, language, and style in reports **Business Proposal Writing:** Types of business proposals, format of proposal, language and style, presentation of proposal **Plagiarism:** Types of plagiarism, consequences of plagiarism	**06**
	Unit 2: Employment Skills	
2	**Group Discussion:** Purpose of a GD, types of GD, criteria for evaluating GD, Dos and Don'ts of GD **Resume Writing:** Types of resumes, structure, content, and formatting of resume **Interview Skills:** Types and modes of interview, Preparation for interview, Dos and Don'ts of interview, frequently asked questions during interview **Presentation Skills:** Presentation strategies, overcoming stage fear, techniques to prepare effective PowerPoint presentation	**08**
	Unit 3: Corporate Story Telling	
3	**Basics of storytelling:** Setting, characters, plot, crisis, climax, resolution, Benefits of storytelling **Types of stories:** Elevator pitch, product stories, event stories, stories in presentations, storytelling in SOP's and interviews, storytelling to manage conflict or to motivate **Storytelling techniques:** Narration using verbal and non-verbal communication, Analysis of storytelling strategies of corporate master storytellers	**03**
	Unit 4: Meetings and Documentation	
4	**Planning and preparation for meetings:** Planning layout of meetings, arranging logistics, defining roles and responsibilities	**02**

	Strategies for conducting effective meetings: Follow the agenda**,** record discussion, observe meeting decorum **Documentation:** Draft notice, agenda, and minutes of meeting **Business meeting etiquettes: V**erbal and non-verbal aspects of etiquettes	
	Unit 5: Introduction to Interpersonal Skills	
5	**Emotional Intelligence:** Definition, difference between IQ and EQ, how to develop EQ **Leadership:** Types of leadership, leadership styles, case studies **Team Building:** Difference between group and team, importance of teamwork, strategies to be a good team player **Time Management:** Importance of time management, cultural views of time, 80/20 rule, time wasters, setting priorities and goals **Conflict Management:** Types of conflicts, strategies to manage conflict, case studies	**05**
	Unit 6: Cross-cultural communication and Professional ethics	
6	**Communication across cultures**: Understanding cultures and developing sensitivity towards cultural differences **Corporate etiquettes**: Telephone, dining, cubicle etiquette, etc. **Professional ethics:** Effective work habits, accountability, integrity, and excellence	**02**
	Total	**26**

Professional and Business Communication Laboratory (**DJS22IHL)**	
Exp.	**Suggested exercises/experiments**
1	Draft a questionnaire for survey analysis
2	Prepare individual resume
3	Compose responses for frequently asked questions in an interview
4	Create a Power point presentation
5	Use storytelling in a given corporate situation
6	Conduct a mock meeting and prepare the related documents
7	Perform a team building activity
8	Perform an interpersonal skills related activity
9	Discuss a case related to professional ethics
10	Perform a role play on corporate etiquettes

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

Books Recommended:

- Fred Luthans, *"Organizational Behavior",* McGraw Hill, edition
- Lesiker and Petit, *"Report Writing for Business",* McGraw Hill, edition
- Huckin and Olsen, *"Technical Writing and Professional Communication",* McGraw Hill

- Wallace and Masters, *"Personal Development for Life and Work",* Thomson Learning, 12th edition
- Heta Murphy*, "Effective Business Communication",* Mc Graw Hill, edition
- Sharma R.C. and Krishna Mohan, *"Business Correspondence and Report Writing",* Tata McGraw-Hill Education
- Ghosh, B. N., *"Managing Soft Skills for Personality Development",* Tata McGraw Hill. Lehman,
- Bell, Smith, "Management Communication" Wiley India Edition, 3rd edition.
- Dr. Alex, K.," Soft Skills", S Chand and Company
- Subramaniam, R., "Professional Ethics" Oxford University Press.
- Sandeep Das, "How Business Story Telling Works: Increase Your Influence and Impact" Penguin Random House India Pvt. Ltd.

Program: Mechanical Engineering	T.Y. B.Tech	Semester: VI
Course: CAD CAM Laboratory (DJS22MEL604)		

Pre-requisite: --

1. Knowledge of Engineering Graphics, Machine Drawing.
2. Knowledge of Drafting softwares such as AutoCAD, Autodesk Inverter etc.
3. Knowledge of Lathe, Milling, CNC Turning, CNC Milling Machines and 3 D Printers.

Objectives:

1. To introduce the concepts of computer aided engineering for design & manufacture and familiarize them with mathematical basis of computer graphics.
2. To impart knowledge on computer graphics, which are used routinely in diverse areas like science, engineering, medicine etc.

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

1. Understand software configuration of graphic packages.
2. Understand use of Computer graphics in design.
3. Understand Modeling of simple machine parts and assemblies from the part drawings using standard CAD packages.
4. Understand to Generate CNC Turning and Milling codes for different operations using standard CAM packages and write manual part programming using ISO codes for turning and milling operations.

CAD CAM Laboratory (DJS22MEL604)	
Exp.	**Suggested experiments**
1	Programming for transformations by using coding language (Translation, Rotation, Scaling & Magnification)
2	Solid modelling using any 3D modeling software
3	Part programing and part fabrication on CNC trainer (Turning / Milling)
4	Creating a script for generating a component or a sketch on software.
5	Simulation of turning operation program on software.
6	Simulation of milling operation program on software.
7	Program and Process Sheet Generation for turning operation by using CAM Software. (Two components)
8	Program and Process Generation for Milling operation by using CAM Software (Two components)
9	Development of physical 3D mechanical component using any one of the additive manufacturing technique 3 D printer.
10	Development of physical 3D mechanical component on Automatic Turning centre (Computerized)

11	Development of physical 3D mechanical component on vertical Machining Centre (Computerized).

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:

Text books:

- Mikell P. Groover and Emory W. Zimmers; CAD/CAM: Computer Aided and Manufacturing, Pearson Education, 2013.
- Ibrahim Zeid, R. Sivasubramanian ; CAD/ CAM: Theory & Practice, Tata McGraw Hill Publications, 2009.
    1. P.N. Rao; CAD/CAM Principles and Applications, Tata McGraw Hill Publications, 2017.

Reference Books:

- Donald Hearn and M. Pauline Baker ; Computer Graphics, Pearson Education, 2006.
- William.M. Neumann and Robert.F. Sproul; Principle of Interactive Computer Graphics, McGraw Hill publishers, 1979.
- David L. Goetsch; Fundamental of CIM technology, Delmar publication, 1988.
- David Bedworth; Computer Integrated Design and Manufacturing, McGraw Hill publishers, 1991.
- B.S. Pabla and M. Adithan; CNC Machines, New Age International Publishers, 2018.
- T.K. Kundra, P.N. Rao and N.K. Tiwari; Numerical Control and Computer Aided Manufacturing, Tata McGraw Hill publishers, 1985.
- Krar S. and Gill A.; CNC Technology and Programming, McGraw Hill publishers, 1990.
- Paul G. Ranky; Computer Integrated Manufacturing - An Introduction with Case Studies, Prentice Hall International. 1986.
- Ian Gibson, David W Rosen, Brent Stucker., Mahyar Khorasani; Additive Manufacturing Technologies, Springer, 2021.
- Juan Pou, Antonio Riveiro and J. Paulo Davim; Additive Manufacturing, Elsevier, 2021.
- M. Manjaiah, K. Raghavendra, N. Balashanmugam, J. Paulo Davim; Additive Manufacturing (A Tool for Industrial Revolution 4.0), Woodhead Publishing, 2021.

Program: Mechanical Engineering	T.Y. B. Tech	Semester: VI
Course: Innovative Product Development IV (DJS22ILLL2)		

Pre-requisite: --

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 analyse the impact of the proposed method of design and development of the product.
5. Develop interpersonal skills, while working as a member of the team or as the leader.
6. Demonstrate capabilities of self-learning as part of the team, leading to life-long learning, which could eventually prepare themselves to be successful entrepreneurs.
7. Demonstrate product/project management principles during the design and development work and also excel in written (Technical paper preparation) as well as oral communication.

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 in the team shall understand the effective need for product development and accordingly select the best possible design in consultation with the faculty supervisor.
- Students shall convert the best design solution into a working model, using various components drawn from their domain as well as related interdisciplinary areas.
- Faculty supervisor may provide inputs to students during the entire span of the activity, spread over **2 semesters**, wherein the main focus shall be on self-learning.
- A record in the form of an activity log-book is to be prepared by each team, wherein the team can record weekly progress of work. The guide/supervisor should verify the recorded notes/comments and approve the same on a weekly basis.

- The design solution is to be validated with proper justification and the report is to be compiled in a standard format and submitted to the department. Efforts are to be made by the students to try and publish a technical paper, either in the institute journal, "Techno Focus: Journal for Budding Engineers" or at a suitable publication, approved by the department research committee/ 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 V and VI.

Guidelines for Assessment of the Term work:

1. 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.
2. 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.
3. Distribution of marks individually for the both reviews as well as for the first review during the subsequent semester shall be as given below:

A. Marks awarded by the supervisor based on log-book	: 10
B. Marks awarded by review committee	: 10
C. Quality of the write-up	: 05

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

Marks awarded by the supervisor (Considering technical paper writing)	: 15
Marks awarded by the review committee	: 10

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

In the 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.

1. The overall work done by the team shall be assessed based on the following criteria:
2. Quality of survey/ need identification of the product.
3. Clarity of Problem definition (design and development) based on need.
4. Innovativeness in the proposed design.
5. Feasibility of the proposed design and selection of the best solution.
6. Cost effectiveness of the product.
7. Societal impact of the product.
8. Functioning of the working model as per stated requirements.
9. Effective use of standard engineering norms.
10. Contribution of each individual as a member or the team leader.
11. 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 design and the development of the product shall be assessed through a presentation and demonstration of the working model by the student team to a panel of Internal and External Examiners, preferably from industry or any research organizations having an experience of more than five years, approved by the Head of the Institution. The presence of the external examiner is desirable only for the 2nd presentation in semester VI. Students are compulsorily required to present the outline of the technical paper prepared by them during the final review in semester VI.