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)

Second Year B. Tech

In

(Semester III & IV)

Scheme for Second Year B. Tech Program in Mechanical Engineering: Semester III
(Academic Year 2023-2024)

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	DJS22MEC301	Engineering Mathematics III	3	--	-	3	35	--	35	65	--	--	--	65	100	3	**4**
	DJS22MET301	Engineering Mathematics III Tutorial	--	--	1	1	--	25	25	--	--	--	--	--	25	1	
2	DJS22MEC302	Engineering Thermodynamics	3	--	-	3	35	--	35	65	--	--	--	65	100	3	**3**
3	DJS22MEC303	Mechanics of Materials	3	--	-	3	35	--	35	65	--	--	--	65	100	3	**4**
	DJS22MEL303	Mechanics of Materials Laboratory	--	2	-	1	--	25	25	--	25	--	--	25	50	1	
4	DJS22MEC304	Manufacturing Processes	2	--	-	2	35	--	35	65	--	--	--	65	100	2	**2**
5	DJS22MEL305	Computer Aided Machine Drawing Laboratory	--	4	-	2	--	50	50	--	--	--	50	50	100	2	**2**
6	DJS22MEL306	Manufacturing Processes Laboratory	--	4	-	2	--	50	50	--	--	50	--	50	100	2	**2**
7	DJS22IHC1	Universal Human Values	2	--	-	2	35	--	35	65	--	--	--	65	100	2	**3**
	DJS22IHT1	Universal Human Values Tutorial	--	--	1	1	--	25	25	--	--	--	--	--	25	1	
8	DJS22MEL307	Python for Mechanical Engineering Laboratory	--	2	-	1	--	25	25	--	--	25	--	25	50	1	**1**
9	DJS22ILLA1	Innovative Product Development I	--	2	-	--	--	--	--	--	--	--	--	--	--	--	--
		Total	**13**	**14**	**2**	**21**	**175**	**200**	**375**	**325**	**25**	**75**	**50**	**475**	**850**	**21**	

Th	Theory	**T/W**	Termwork
P	Practicals	**O**	Oral
T	Tutorial	**Cb**	Computer based

Prepared by Checked by Head of the Department Principal

Scheme for Second Year B. Tech Program in Mechanical Engineering : Semester IV
(Academic Year 2023-2024)

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	DJS22MEC401	Engineering Mathematics IV	3	--	--	3	35	--	35	65	--	--	--	65	100	3	**4**
	DJS22MET401	Engineering Mathematics IV Tutorial	--	--	1	1	--	25	25	--	--	--	--	--	25	1	
2	DJS22MEC402	Fluid Mechanics	3	--	-	3	35	--	35	65	--	--	--	65	100	3	**4**
	DJS22MEL402	Fluid Mechanics Laboratory	--	2	-	1	--	25	25	--	25	--	--	25	50	1	
3	DJS22MEC403	Kinematics of Machinery	3	--	-	3	35	--	35	65	--	--	--	65	100	3	**4**
	DJS22MEL403	Kinematics of Machinery Laboratory	--	2	-	1	--	25	25	--	--	--	--	--	25	1	
4	DJS22MEC404	Engineering Materials	2	--	-	2	35	--	35	65	--	--	--	65	100	2	**3**
	DJS22MEL404	Material Testing Laboratory	--	2	-	1	--	25	25	--	--	--	--	--	25	1	
5	DJS22MEC405	Advanced Manufacturing Processes	2	--	-	2	35	--	35	65	--	--	--	65	100	2	**2**
6	DJS22MEC406	Mechanical Measurement and Metrology	3	--	-	3	35	--	35	65	--	--	--	65	100	3	**4**
	DJS22MEL406	Mechanical Measurement and Metrology	--	2	-	1	--	25	25	--	--	--	--	--	25	1	
7	DJS22MEL407	Advance Manufacturing Processes Laboratory	--	4	-	2	--	50	50	--	--	50	--	50	100	2	**2**
8	DJS22A2	Constitution of India	1	--	-	--	--	--	--	--	--	--	--	--	--	--	-
9	DJS22ILLA2	Innovative Product Development II	--	2	-	--	--	--	--	--	--	--	--	--	--	--	-
		Total	**17**	**14**	**1**	**23**	**210**	**175**	**385**	**390**	**25**	**50**	**0**	**465**	**850**	**23**	

Th	Theory	**T/W**	Termwork
P	Practicals	**O**	Oral
T	Tutorial	**Cb**	Computer based

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Continuous Assessment (A):

Course	Assessment Tools	Marks	Time (hrs.)
Theory	a. One Term test (based on 40 % syllabus)	20	1
	b. Second Term test (next 40 % syllabus) / presentation / assignment / course project / group discussion / any other.	15	1
	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 &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 the 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 / 50	2 / 3
Oral & Practical	Project based courses - Performance of the practical assigned during the examination and the output / results obtained. Based on the practical performed during the examination and on the entire syllabus.	as per the scheme	2

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Program: Mechanical Engineering	S.Y. B. Tech	Semester: III
Course: Engineering Mathematics-III (DJS22MEC301)		
Course: Engineering Mathematics-III Tutorial (DJS22MET301)		

Objectives:

1. To provide a sound foundation in the mathematical fundamentals necessary to formulate, solve and analyze engineering problems.
2. To study the basic principles of Laplace Transform, Fourier Series and complex variables.

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

1. Use Laplace and inverse Laplace Transform to solve the Ordinary Differential Equations.
2. Identify analytic and harmonic functions.
3. Solve real integrals using complex integration.
4. Find the Fourier Series of periodic functions and simplify infinite series.
5. Solve certain partial differential equations analytically and numerically.
6. Correlate different variables of data.

Engineering Mathematics-III (DJS22MEC301)		
Unit	**Description**	**Duration**
1	**Laplace Transform** LT of standard functions such as 1, t^n,e^{at}, sin *at*, cos *at*, sinh *at*, cosh *at*, Heaviside Unit step function, Dirac Delta function, Periodic functions. Linearity property of Laplace Transform, First Shifting property, Second Shifting property, Change of Scale property of L.T. (without proof) $$L\{t^n f(t)\}, L\left\{\frac{f(t)}{t}\right\}, L\left\{\int_o^t f(u)\,du\right\}, L\left\{\frac{d^n f(t)}{dt^n}\right\}.$$ **Inverse Laplace Transform** Linearity property, Partial fractions method and convolution theorem. Applications to solve ordinary differential equations with one dependent variable with given boundary conditions.	**9**
2	**Complex Variables, Differentiation** Analytic functions, Cauchy-Riemann equations in Cartesian and polar coordinates (only statement). Milne-Thomson method to determine analytic function when it's real or imaginary or its combination is given. Harmonic function, orthogonal trajectories. Bilinear Transformation with fixed points, cross-ratio **(For Self-Study).**	**6**
3	**Complex Integration** **Line** integral **(For Self-Study)**, Cauchy's theorem for analytic function, Cauchy's integral formula (all without proof). Taylor's and Laurent's series. Residue at removable singularity, poles, isolated singularity, and its evaluation. Residue theorem, application to evaluate real integral of type.	**6**

	$\int_0^{2\pi} f(cos\theta, sin\theta)d\theta,\ \int_{-\infty}^{\infty} f(x)dx$	
4	**Fourier Series** Fourier series of periodic functions with period 2π & 2*l*. Even and odd functions, Half range sine and cosine series, Parseval's identities (without proof). Complex form of Fourier series. Orthogonal and Orthonormal functions. **(For Self-Study)**	**6**
5	**Partial Differential Equations** Numerical Solution of PDE using Bender-Schmidt Method and Crank- Nicolson method. Partial differential equations governing transverse vibrations of an elastic string and its solution using Fourier series. Heat equation, steady-state configuration for heat flow **(For Self-Study).**	**6**
6	**Correlation, Regression** Correlation-Karl Pearson's coefficient of correlation, Spearman's Rank correlation, Regression analysis- lines of regression.	**6**
	Total	**39**

Engineering Mathematics - III Tutorial (DJS22MEC301)	
Tut.	**Suggested Tutorials**
1	Laplace transform.
2	Inverse Laplace transform.
3	Special Unit functions, Solving differential equations(related to Mechanical engineering) using Laplace transform.
4	Analytic functions, Milne-Thomson method to determine analytic function.
5	Bilinear Transformation with fixed points, cross-ratio.
6	Line Integration.
7	Cauchy's theorem and Cauchy's Integral formula problems.
8	Taylor's and Laurent's Series expansion.
9	Residue theorem, application to evaluate real integrals.
10	Fourier series, Parseval's identity.
11	Even and odd functions, Half Range series
12	Complex form of Fourier series. Orthogonal and Orthonormal functions.
13	Bender-Schmidt Method and Crank- Nicolson method.
14	Partial differential equations governing transverse vibrations of an elastic string and its solution using Fourier series, Heat equation, steady-state configuration for heat flow.
15	Correlation, Regression .

Tutorials:
Minimum eight tutorials based on the syllabus will be conducted. A mini project relevant to the subject may be included, which would help the learner to apply the concept learnt.

Books Recommended:

Textbooks:

1. Higher Engineering Mathematics, Dr. B. S. Grewal, Khanna Publication.
2. Advanced Engineering Mathematics, E Kreyszing, Wiley Eastern Limited.

References:

1. Higher Engineering Mathematics, B.V. Ramana, McGraw Hill Education, New Delhi.
2. Complex Variables: Churchill, Mc-Graw Hill.
3. Integral Transforms and their Engineering Applications, Dr B. B. Singh, Synergy Knowledge ware, Mumbai.
4. Numerical Methods, Kandasamy, S. Chand & CO.
5. Fundamentals of Mathematical Statistics by S.C. Gupta and Kapoor.

Program: Mechanical Engineering	S.Y. B. Tech	Semester: III
Course: Engineering Thermodynamics (DJS22MEC302)		

Objectives:

1. To familiarize the concepts of Energy in general and Heat and Work in particular.
2. To study the fundamentals of quantification and grade of energy.
3. To study the effect of energy transfer on the properties of substances in the form of charts and diagrams.
4. To familiarize application of the concepts of thermodynamics in vapour power and gas power cycles.

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

1. Demonstrate application of the first law of thermodynamics to flow and non-flow system
2. Analyze thermodynamic cycles including vapor power cycles, refrigeration cycles, and heat-pump.
3. Use thermodynamic relations in the evaluation of thermodynamic properties.
4. Use steam table and Mollier chart to compute thermodynamics interactions
5. Evaluate the performance of air standard cycles.
6. Evaluate the performance of single stage and multi stage compressor.

Engineering Thermodynamics (DJS22MEC302)		
Unit	**Description**	**Duration**
1	**First Law of Thermodynamics** Basics concepts of thermodynamics, quasi-static process, Relation between Heat and Work-Joules Constant, First law of thermodynamics for a closed system undergoing a cycle and change of state. Conservation principle, First Law of Thermodynamics applied to open system – Steady Flow Energy Equation, Perpetual motion Machine of First kind. Application of first law of thermodynamics to Open Systems like Steam Nozzle, Boiler, Steam Turbine, Pump, Heat Exchanger, Throttling Process.	**8**
2	**Second Law of Thermodynamics:** Limitation of first law of thermodynamics, Thermal Reservoir – Source and Sink, Concept of Heat Engine, Heat Pump and Refrigerator, Second law of thermodynamics – Kelvin Planck and Clausius Statements. Equivalence of Clausius and Kelvin Planck Statement, Reversible and Irreversible Process. Causes of Irreversibility, Perpetual Motion Machine of Second Kind, Need of Carnot theorem and its corollaries, Carnot cycle, Thermodynamic Temperature Scale and its equivalence with Ideal Gas Scale **Entropy:** Clausius Inequality, Clausius Theorem, Entropy is Property of a system, Isentropic Process, Temperature Entropy Plot and its relationship with heat interactions, Entropy Principle, Entropy change During a Process. Interpretation of concept of entropy.	**9**
3	**Thermodynamic Relations:** Reciprocal Relation, Cyclic Relation Property relations, Maxwell Relations, TdS equations, Heat capacity relations, Volume Expansivity, Isothermal Compressibility, Clausius Clapeyron Equation **Exergy:** High grade and Low-Grade Energy, Available and Unavailable Energy, Dead State, Available energy with respect to a process and a cycle.	**4**

4	**Properties of Pure Substance:** Pure substance and Phase changes: Phase change processes of pure substance, Property diagrams for phase change process (T-v, T-s and p-h diagrams), Understanding of Steam Table and Mollier chart. **Vapour Power cycle:** Carnot cycle and its limitations as a vapour cycle, Rankine cycle with different turbine inlet conditions, mean temperature of heat addition, Methods to improve thermal efficiency of Rankine cycle – Reheat cycle and Regeneration Cycle.	**6**
5	**Gas Power cycles:** Assumptions of Air Standard Cycle, Otto cycle, Diesel Cycle and Dual cycle, Applications of gas turbine, Actual Brayton cycle, open and closed cycle gas turbine, methods to improve efficiency and specific output, open cycle with intercooling, reheat, and regeneration, Effect of operating variable on thermal efficiency and work ratio.	**6**
6	**Compressors:** Reciprocating Air Compressor, Single stage compressor – computation of work done, isothermal efficiency, effect of clearance volume, volumetric efficiency, Free air delivery, Theoretical and actual indicator diagram, Multistage compressors – Constructional details of multistage compressors, Need of multistage, Computation of work done, Volumetric efficiency, Condition for maximum efficiency, Inter cooling and after cooling (numerical), Theoretical and actual indicator diagram for multi stage compressors.	**6**
	Total	**39**

Books Recommended:

Text books:

1. Thermodynamics by P K Nag, Tata McGraw Hill Publishers.
2. Thermodynamics by Onkar Singh, New Age International.

Reference Books:

1. Thermodynamics: An Engineering Approach by Yunus A. Cengel and Michael ABoles,7th edition, TMH
2. Fundamentals of Engineering Thermodynamics by Michael J. Moran and Howard N. Shapiro, Wiley
3. Fundamentals of Thermodynamics by Claus Borgnakke and Richard E. Sonntag, Wiley
4. Engineering Thermodynamics by P Chattopadhyay, Oxford University Press India

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Program: Mechanical Engineering	S.Y. B.Tech	Semester: III
Course: Mechanics of Materials (DJS22MEC303)		
Course: Mechanics of Materials Laboratory (DJS22MEL303)		

Objectives:

1. To gain knowledge of different types of stresses, strains, and deformations induced in the mechanical components due to external loads.
2. To study the distribution of various stresses in mechanical elements that deform under loads.
3. To study the effect of component dimensions and materials properties on stresses and deformations.

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

1. Evaluate stresses, strains, deformation, and properties of materials in mechanical components/ structures.
2. Draw SFD and BMD for several types of loads and support conditions for a beam.
3. Compute and plot direct, bending and shear stresses across sections of a given beam.
4. Compute torsional shear stresses and strain energy in mechanical components.
5. Compute deflections and slopes in beams.
6. Analyze buckling phenomenon in columns and struts.

Mechanics of Materials (DJS22MEC303)		
Unit	**Description**	**Duration**
1	**Moment of Inertia:** Centroid, Area Moment of Inertia, Parallel Axis theorem, Polar Moment of Inertia, Principal axes, Principal moment of inertia. **Stress and Strain:** Definition, Simple stress-strain, uni-axial, bi-axial and tri-axial stresses, tensile stress, compressive stress and shear stresses, elastic limit, Hooke's Law, deformation due to self-weight, bars of varying sections, composite sections, deformation of tapering members, Thermal Stresses. **Elastic Constants and their relations:** Poisson's Ratio, Modulus of elasticity, Modulus of rigidity, Bulk modulus, Yield stress, Ultimate stress. Factor of safety, state of simple shear, relation between elastic constants, Volumetric strain for tri-axial loading.	**8**
2	**Shear Force and Bending Moment in Beams:** Axial force, shear force and bending moment diagrams for statically determinate beams (excluding beams with internal hinges), relationship between rates of loading, shear force and bending moment.	**6**
3	**Bending stresses:** Theory of pure Bending, Assumptions, Flexural formula for straight beams, moment of resistance, bending stress distribution, Section modulus, beams of uniform strength. **Shear Stresses:** Distribution of shear stresses for the section of beam.	**6**

4	**Torsion:** Torsion of circular shafts-solid and hollow, stresses in shafts when transmitting power, shafts in series and parallel. **Principal stresses and Strains:** Principal plane and principal stresses, analytical and graphical method (Mohr's circle) for determining stresses on the oblique section.	**6**
5	**Deflection of Beams:** Deflection of Cantilever, simply supported and over hanging beams using Macaulay's or double integration method for different type of loadings.	**6**
6	**Columns and Struts:** Buckling load, crushing load, Types of end conditions for column, Euler's column theory and its limitations, Rankine- Gordon Formula. **Strain Energy:** Resilience, Proof Resilience, strain energy stored in the member due to gradually applies load, suddenly applied load, impact load. Strain energy stored due to Shear, Bending and Torsion.	**7**
	Total	**39**

An experiential learning approach for strength of materials should provide students with hands-on experience and practical applications of the concepts of strength, stiffness, and stability of structural members through Laboratory experiments, Field trips, Design projects, Case studies and Computer simulations.

Laboratory experiments: Conducting laboratory experiments can provide students with hands-on experience in measuring the strength and stiffness of various materials and structural members.

Field trips: Field trips to manufacturing plants or construction sites can provide students with a real-world perspective on how materials and structures are used in industry.

Case studies: Case studies can provide students with examples of how strength and stiffness are important in engineering design.

Mechanics of Materials Laboratory (DJS22MEL303)	
Exp.	**Suggested experiments**
1	Tension test on mild steel bar (stress-strain behaviour, determination of yield strength and modulus of elasticity) using Universal Testing Machine (UTM).
2	Impact test on metal specimen (Izod test/ Charpy test).
3	Hardness test on metals – (Brinell Hardness Number / Rockwell Hardness Number).
4	Flexural test on beam (central loading).
5	Flexural test on beam (two-point loading).
6	Torsion test on mild steel bar / cast iron bar.

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

Assignments:

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

Books Recommended:

Text books:

1. Strength of Materials by S. Ramamrutham, Dhanpat Rai Pvt. Ltd.
2. Mechanics of Materials by S.S.Ratan, Tata McGraw Hill Pvt. Ltd.
3. Strength of Materials by R. Subramanian, Oxford University Press, Third Edition 2016

Reference Books:

1. Strength of Materials by Ryder, Macmillan
2. Mechanics of Materials by James M. Gere and Barry J. Goodno, Cengage Learning.
3. Mechanics of Materials by Gere and Timoshenko, CBS.
4. Strength of Materials by Basavrajaiah and Mahadevappa, Khanna Publishers,New Delhi.
5. Elements of Strength of Materials by Timoshenko and Youngs, Affiliated East -West Press.
6. Mechanics of Materials by Beer, Jhonston, DEwolf and Mazurek, TMH Pvt Ltd., New Delhi.
7. Mechanics of Structures by S.B. Junnarkar, Charotar Publication.
8. Introduction to Solid Mechanics by Shames, PHI.
9. Strength of Materials by Nag and Chandra, Wiley India.
10. Strength of Materials by W. Nash, Schaum's Outline Series, McGraw Hill Publication, Special Indian Edition.

Program: Mechanical Engineering	S. Y. B. Tech	Semester: III
Course: Manufacturing Processes (DJS22MEC304)		

Objectives:

1. To impart the knowledge of manufacturing processes like casting, forging, rolling, metal cutting processes like turning, drilling, thread cutting etc.
2. To train the students in machining various operations on CNC to enrich their practical skills.
3. To impart the fundamentals of various power metallurgy techniques and various polymeric composite manufacturing.

Outcomes: Learner will be able to…

1. Describe types of machine tools, their classification, specifications, and constructional features, with machining operations to generate cylindrical, and planar components.
2. Identify various metal casting processes, analyze various defects, their probable causes and remedial measures confronted with metal casting.
3. Identify various metal forming, analyze various defects, their probable causes and remedial measures confronted with metal forming.
4. Identify sheet metal operations to build the concepts pertaining to press tools.
5. Calculate various forces, velocities, shear angle, strain, shear stress and power consumption in meta cutting operation.
6. Describe various power metallurgy techniques and various polymeric composite manufacturing techniques.

Manufacturing Processes (DJS22MEC304)		
Unit	**Description**	**Duration**
1	**Introduction to Manufacturing Processes:** Need and classification of manufacturing process based on chip-less and chip-removal processes. Various generating & forming processes. Illustrate machine tools required to generate cylindrical and planar components. **Metal Cutting Processes:** Machine tools: lathe, drill, shaper, milling, gear hobbing and grinding, their operations, operating parameters, MRR, various cutting tools, accessories, and attachments. Super finishing processes like, Honing, Lapping, Buffing and Polishing. **(Metal Cutting Processes To be covered in laboratory)**	**2**
2	**Metal Casting Process -** Expendable and Permanent Mould Casting Processes – sand casting, investment casting, shell moulding, die casting, centrifugal casting, vacuum casting, casting defects and their remedies. **Metal Joining Processes -** Classification of welding, Fusion welding processes like - Gas welding, Arc welding, Resistance, Electron beam welding, laser beam welding. Solid state welding processes like – friction welding, ultrasonic welding, and Thermo-chemical welding processes. Soldering and brazing processes. Welding defects, inspection & testing of welds, Safety in welding. **(Metal Joining Processes To be covered in laboratory)**	**4**

3	**Rolling**: Principles and process characteristics, rolling types, rolling parameters, Thread rolling, Production of seamless tubes through rolling, defects, and remedies in rolling process. **Forging**: Basic operations, types of forging, forging hammers/ presses, forging stages, forging applications, defects, and remedies in forging process. **Extrusion:** Equipment and principles, types of extrusion, direct, indirect, impact, continuous, hydrostatic, tube extrusion, metal flow in extrusion, defects and remedies in extrusion, wire drawing process. **Sheet Metal Operations**: Theory in Press Working, Functions of different elements of a press tool, Press working operations: piercing, blanking, notching, embossing, coining, bending, forming and drawing operations. Benefits and limitations of using Press tools. Applications of pressed parts/components.	**8**
4	**Theory of Metal Cutting** Introduction, machining parameters, orthogonal and oblique cutting, mechanism of metal cutting, types of chips, Merchant's circle diagram, calculation of cutting forces, shear stress and strain, strain rate, power requirement, Geometry of Single point cutting tool (SPTT), Significance of various angles of SPTT, ISO coding for tipped tools and tool holders.	**5**
5	**Powder Metallurgy** - Principles of powder metallurgy, Processes of powder making, mechanisms of sintering, CIP and HIP, Finishing operations in Powder metallurgy, Applications of Powder metallurgy. **Polymeric composites manufacturing process** - Injection Moulding, Compression moulding, transfer moulding, blow moulding, Rotational Moulding, Thermoforming and Extrusion.	**4**
6	**Manufacturability assessment of given product design.** Classifying operations, basic process operation, principal process and auxiliary process. **Process planning of complete manufacturing process for a given components.**	**3**
	Total	**26**

Books Recommended:

Reference Books:

1. Elements of Workshop Technology: Machine Tools by S. K. Hajra Choudhary, A. K. Hajra Choudhary, Nirjhar Roy, Media promoters 15th edition (2010).
2. A Course in Workshop Technology Vol. II (Machine Tools) by B. S. Raghuvanshi, Dhanpat Rai & Co. (2019).
3. Production Technology – HMT, Tata McGraw-Hill (2017).
4. A Textbook of Production Technology Vol. I and II by O. P. Khanna, Dhanpat Rai Publication 19th edition.
5. Fundamentals of Modern Manufacturing- Materials, Processes and Systems, 7th edition by Mikell P. Groover, Wiley India (May 2019).
6. Manufacturing Processes for Engineering Materials, 8th edition by Serope Kalpakjian, Steven R. Schmid, Pearson (2020).
7. Manufacturing Processes by P. N. Rao, Vol. 1 (5th edition) and Vol. 2 (4th edition), McGraw Hill Publishers (2018).

8. Welding Technology by O. P. Khanna, Dhanpat Rai & Co (2015).
9. Composites Manufacturing – Materials, product, and Process Engineering by Sanjay K. Muzumdar, CRC Press (2002).
10. Process Engineering for Manufacturing, Donald F. Eary and Gerald E. Johnson, Prentice-Hall, Inc.

Program: Mechanical Engineering	**S.Y. B. Tech**	**Semester: III**
Course: Computer Aided Machine Drawing lab (DJS22MEL305)		

Objectives:

1. To familiarize with the conversion of an object into a drawing
2. To study conventional representation of various machining and mechanical details as per IS
3. To become conversant with 2-D and 3-D drafting

Outcomes: Learner will be able to…

1. Visualize and prepare detailed drawing of a given object.
2. Read and interpret the drawing
3. Draw the details and assemblies of different mechanical systems.
4. Convert detailed drawing into assembly drawing using modelling software
5. Convert assembly drawing into detailed drawing using modelling software
6. Prepare a detailed drawing of any given physical object / machine element with actual measurements

Unit	Description	Practical
1	**Introduction**: Review of graphic interface, various tools and settings for preparation of graphics work space. Introduction of basic sketching commands (Line, circle, arc, rectangle, slot, spline, fillet polygon, text, dimensioning etc.) modify commands (move, trim, copy, replace, extend, split, offset etc.), feature commands (extrude, revolve, loft, sweep, rib, coil, emboss etc.) and navigational commands (Pan, zoom in, zoom out, orientation etc.). Types of drawing sheets and its sizes, Drawing units, grid and snap, title block. Conversion of 3D views into orthographic projections of simple machine parts like (nuts, bolts, keys, screws, spring etc.), Editing, Hidden line view, shaded view, render view, presentation of various view along with different orientations.	6
2	**Details and assembly drawings**: Types of assembly drawings, part drawings, drawings for catalogues and instruction manuals, patent drawings, drawing standards, Introduction to unit assembly drawing, steps involved in preparing assembly drawing from details and vice-versa. **Geometric Dimensions and Tolerances (GD&T):** Introduction of Limits, fits, deviations, and tolerances with their applications, dimensioning with tolerances indicating various types of fits in details and assembly. **Conventional representation of threaded parts**: Types of threads, thread designation, Thread terminology, sectional views of threads. ISO Metric (Internal & External) BSW (Internal & External) square and Acme, American Standard thread.	6
3	**Preparation of details/assembly drawings of Machinery parts, Joints and Keys, Couplings:** **Machinery parts** Clapper block, Single tool post, Lathe and Milling tail stock, jigs and fixtures **Joints and Keys** Cotter joints, knuckle joints, keys-sunk, parallel woodruff, saddle, feather etc. **Couplings** simple, muff, flanged Protected flange coupling, Oldham's coupling, Universal coupling	12

4	**Preparation of details / assembly drawings of Bearings** Simple bearing, Solid bearing, Bushed bearing, I.S. conventional representation of ball and roller bearing, Pedestal bearing, footstep bearing.	**8**
5	**Preparation of details / assembly drawings of pulleys, Pipe joints:** **Pulleys:** Flat belt, V-belt, rope belt, Fast and loose pulleys. **Pipe joints :** Flanged joints, Socket and spigot joint, Gland and stuffing box, expansion joint	**8**
6	**Preparation of details / assembly drawings of Valves:** Air cock; Blow off cock, Steam stop valve, Gate valve, Globe valve, non-return Valve, **Preparation of details / assembly drawings of I.C. Engine parts:** Piston, Connecting rod, Cross head, Crankshaft, Carburetor, Fuel pump, injector, and Spark plug. **Introduction to Reverse Engineering of a physical model:** Historical Background, scope and task of Reverse Engineering in Modern Industries, Applications of Reverse Engineering & 3D scanning.	**12**
	TOTAL	**52**

List of Laboratory Experiments:

PART A :(Any six)

1. General machine elements - nuts, bolts, keys, cotter, screws, spring etc. (any one)
2. Details/Assembly of Clapper block, Single tool post, Lathe and Milling tail stock, jigs and fixtures. (any one)
3. Details/Assembly of coupling - simple, muff, flanged Protected flange coupling, Oldham's coupling, Universal coupling. (any one)
4. Details/Assembly of ball and roller bearing, Pedestal bearing, footstep bearing. (any one)
5. Details/Assembly of different types of pulleys. (any one)
6. Details/Assembly of pipe joints - Flanged joints, Socket and spigot joint, Gland and stuffing box, expansion joint. (any one)
7. Details/Assembly of Air cock; Blow off cock, Steam stop valve, Gate valve, Globe valve, Non return Valve. (any one)
8. Details/Assembly of Piston, Connecting rod, Cross head, Crankshaft, Carburetor, Fuel pump, injector, and Spark plug. (any one)

PART B:(Any two)

Reverse engineering drawing of any machine assembly or details of machine system.

Term work

A-3 size Printouts/plots of the problems solved in practical class from the practical part of each module. Problems from practical parts of each module should be solved using any standard CAD packages like IDEAS, PRO-E, CATIA, Solid Works, Inventor etc.

The distribution of marks for Term work shall be as follows:

- Printouts/Plots……. 40 marks
- Attendance…….. 10 marks

End Semester Practical/Oral examination:
To be conducted by pair of Internal and External Examiner

1. Practical examination duration is **three hours**, based on the Term work, and should contain two sessions as follows:

Session-I: Preparation of minimum five detailed 3-D part drawings from given 2-D assembly drawing**.**

Session-II: Preparation of 3-D models of parts, assembling parts and preparing views of assembly from given 2-D detailed drawing.

Oral examination should also be conducted to check the knowledge of conventional and CAD drawing.

2. Questions provided for practical examination should contain a minimum of five and not more than ten parts.

3. The distribution of marks for practical examination shall be as follows:

- **Session-I** ……..….20 marks
- **Session-II** ……..…20 marks
- O**ral** ……..….10 marks

4. Evaluation of practical examination to be done based on the printout of students' work.

5. Students work along with evaluation report to be preserved till the next examination.

Books Recommended:

Reference Books:

1. Machine Drawing by N.D. Bhatt.
2. A textbook of Machine Drawing by Laxminarayan and M.L. Mathur, Jain brothers Delhi
3. Machine Drawing by Kamat and Rao
4. Machine Drawing by M. B. Shah
5. A text book of Machine Drawing by R. B. Gupta, Satyaprakashan, Tech. Publication
6. Machine Drawing by K.I.Narayana, P. Kannaiah, K.Venkata Reddy
7. Machine Drawing by Sidheshwar and Kanheya
8. Autodesk Inventor 2011 for Engineers and Designers by Sham Tickoo and Surinder Raina, Dreamtech Press
9. Engineering Drawing by P J Shah
10. Engineering Drawing by N D Bhatt

Prepared by Checked by Head of the Department Principal

Program: Mechanical Engineering	**S.Y B. Tech**	**Semester: III**
Course Code: Manufacturing Process Laboratory (DJS22MEL306)		

Objectives:

1. To impart the knowledge of machine tools and basic machining processes like turning, drilling, boring, broaching, milling, shaping, planning, slotting, and grinding etc.
2. To provide an insight to different machine tools, accessories, and attachments.
3. To train the students in machine operations to enrich their practical skills.
4. To inculcate team qualities and expose students to shop floor activities
5. To educate the students about ethical, environmental and safety standards.

Outcomes: learner will be able to:

1. Demonstrate precautions and safety norms followed in Machine Shop and exhibit interpersonal skills towards working in a team.
2. Understand the construction, working and operation of various conventional machine tools, and various accessories and attachments used. Select cutting parameters like cutting speed, feed, depth of cut, and tooling for various machining operations.
3. Read working drawings, understand operational symbols and execute machining operations.
4. Perform various operations such as plain turning, taper turning, step turning, thread cutting, facing, knurling, internal thread cutting, eccentric turning and estimate cutting time.
5. Perform machining operations such as plain shaping, inclined shaping, keyway cutting, Indexing and Gear cutting and estimate cutting time.
6. Summarize the importance of grinding and super finishing operations.

Exp.	Experiments
1	One job involving Plain turning, Taper turning, Step turning, Thread cutting, Facing, Knurling, Drilling, Boring, Internal Thread cutting and Eccentric turning on lathe machine. Exercises should include selection of cutting parameters and cutting time estimation.
2	One job involving Cutting of Gear Teeth / Hexagonal nut using Milling Machine and Cutting of V Groove / dovetail / Rectangular groove using a shaper. Exercises should include selection of cutting parameters and cutting time estimation.
3	One job (Group Job) using cylindrical grinding machine. Exercises should include selection of cutting parameters and cutting time estimation.

Remark – Refer theory syllabus for the topics to be covered in laboratory.

Books Recommended:

Reference Books:

1. Workshop Technology by W. A. J. Chapman Vol I & II
2. Workshop Technology by Hazra Choudhary Vol. I & II

Prepared by Checked by Head of the Department Principal

Program: Mechanical Engineering	**S.Y B. Tech**	**Semester: III**
Course: Universal Human Values (DJS22IHC1)		
Course: Universal Human Values Tutorial (DJS22IHT1)		

Objectives:

1. Development of a holistic perspective based on self-exploration about themselves (human being), family, society, and nature/existence.
2. Understanding (or developing clarity) of the harmony in the human being, family, society, and nature/existence.
3. Strengthening of self-reflection.
4. Development of commitment and courage to act.

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

1. Become more aware of themselves, and their surroundings (family, society, nature); they would become more responsible in life, and in handling problems with sustainable solutions, while keeping human relationships and human nature in mind. They would have better critical ability.
2. Become sensitive to their commitment towards what they have understood (human values, human relationships, and human society).
3. Apply what they have learnt to their own self in different day-to-day settings in real life, at least a beginning would be made in this direction.

Universal Human Values (DJS22IHC1)		
Unit	**Description**	**Duration**
1	**Introduction:** Need, Basic Guidelines, Content and Process for Value Education Purpose and motivation for the course. Self-Exploration–what is it? - Its content and process; 'Natural Acceptance' and Experiential Validation- as the process for self-exploration. Continuous Happiness and Prosperity- A look at basic Human Aspirations. Right understanding, Relationship and Physical Facility- the basic requirements for fulfilment of aspirations of every human being with their correct priority. Understanding Happiness and Prosperity correctly- A critical appraisal of the current scenario. Method to fulfil the above human aspirations: understanding and living in harmony at various levels.	**5**
2	**Understanding Harmony in the Human Being** - Harmony in Myself! Understanding human being as a co-existence of the sentient 'I' and the material 'Body'. Understanding the needs of Self ('I') and 'Body' - happiness and physical facility. Understanding the Body as an instrument of 'I' (I am being the doer, seer and enjoyer). Understanding the characteristics and activities of 'I' and harmony in 'I'. Understanding the harmony of I with the Body: Sanyam and Health; correct appraisal of Physical needs, meaning of Prosperity in detail. Programs to ensure Sanyam and Health.	**5**
3	**Understanding Harmony in the Family**: Harmony in Human-Human Relationship. Understanding values in human-human relationship; meaning of Justice (nine universal values in relationships) and program for its fulfilment to ensure mutual happiness; Trust and Respect as the foundational values of relationship. Understanding the meaning of Trust;	**3**

	Difference between intention and competence. Understanding the meaning of Respect, Difference between respect and differentiation; the other salient values in relationship	
4	**Understanding the harmony in society (society being an extension of family):** Resolution, Prosperity, fearlessness (trust) and co-existence as comprehensive Human Goals. Visualizing a universal harmonious order in society- Undivided Society, Universal Order- from family to world family.	**4**
5	**Understanding Harmony in Nature and Existence:** Whole existence as Coexistence Understanding the harmony in the Nature. Interconnectedness and mutual fulfilment among the four orders of nature recyclability and self-regulation in nature. Understanding Existence as Co-existence of mutually interacting units in all pervasive space. Holistic perception of harmony at all levels of existence.	**4**
6	**Implications of the above Holistic Understanding of Harmony on Professional Ethics:** Natural acceptance of human values. Definitiveness of Ethical Human Conduct. Basis for Humanistic Education, Humanistic Constitution and Humanistic Universal Order. Competence in professional ethics: a. Ability to utilize the professional competence for augmenting universal human order, b. Ability to identify the scope and characteristics of people friendly and eco-friendly production systems, c. Ability to identify and develop appropriate technologies and management patterns for above production systems. Case studies of typical holistic technologies, management models and production systems. Strategy for transition from the present state to Universal Human Order: a. At the level of individual: as socially and ecologically responsible engineers, technologists, and managers, b. At the level of society: as mutually enriching institutions and organizations.	**5**
	Total	**26**

Tutorials: (Term work)

Term work shall consist of minimum 5 activities based on activities conducted.

The tutorials could be conducted as per the following topics: -

Activity No 1	Practice sessions to discuss natural acceptance in human being as the innate acceptance for living with responsibility (living in relationship, harmony, and co-existence) rather than as arbitrariness in choice based on liking-disliking.
Activity No 2	Practice sessions to discuss the role others have played in making material goods available to me. Identifying from one's own life. Differentiate between prosperity and accumulation. Discuss program for ensuring health vs dealing with disease.
Activity No 3	Practice sessions to reflect on relationships in family, hostel and institute as extended family, real life examples, teacher-student relationship, goal of education etc. Gratitude as a universal value in relationships. Discuss with scenarios. Elicit examples from students' lives.
Activity No 4	Practice sessions to discuss human being as cause of imbalance in nature (film "Home" can be used), pollution, depletion of resources and role of technology etc.
Activity No 5	Practice Exercises and Case Studies will be taken up in Practice (tutorial) Sessions e.g. To discuss the conduct as an engineer or scientist etc.

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

Books Recommended:

Text books:

1. Human Values and Professional Ethics by R R Gaur, R Sangal, G P Bagaria, Excel Books, New Delhi, 2010.

Reference Books:

1. Jeevan Vidya: Ek Parichaya, A Nagaraj, Jeevan Vidya Prakashan, Amarkantak, 1999.
2. Human Values, A.N. Tripathi, New Age Intl. Publishers, New Delhi, 2004.
3. The Story of Stuff (Book).
4. The Story of My Experiments with Truth - by Mohandas Karamchand Gandhi.
5. Small is Beautiful - E. F Schumacher. 6. Slow is Beautiful - Cecile Andrews.
7. Economy of Permanence - J C Kumarappa.
8. Bharat Mein Angreji Raj – PanditSunderlal.
9. Rediscovering India - by Dharampal.
10. Hind Swaraj or Indian Home Rule - by Mohandas K. Gandhi.
11.India Wins Freedom - Maulana Abdul Kalam Azad.
12.Vivekananda - Romain Rolland. (English)
13.Gandhi - Romain Rolland. (English)

Program: Mechanical Engineering	**S.Y B. Tech**	**Semester: III**
Course: Python for Mechanical Engineering Laboratory (DJS22MEL307)		

Objectives:

1. To understand the coding environment of Python Programming
2. To apply python coding skills for various Mechanical problems.

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

1. Understand the coding environment of Python software.
2. Understand the basics of Python
3. To read, analyze, and visualize data.
4. To apply the python skills for Mechanical problems.

Python for Mechanical Engineering Laboratory (DJS22MEL308)		
Unit	**Description**	**Duration**
1	**Introduction to Python:** Python history, Introduction to Anaconda, Spyder IDE, how to go about programming, understanding of the layout of the programming environment and spyder.	**4**
2	**Basics of Python:** Assignment Statement, variable and datatypes, Loops, Strings, Lists, Operators, Arrays, Sorting, Functions and Dictionaries.	**6**
3	**Data Handling and Manipulation:** Reading Data, Introduction to Pandas Data frame and Numpy, Data Visualization, exploratory Data Analysis.	**6**
4	**Using Python for Mechanical Applications (Design, Thermal and Manufacturing.)**	**10**
	Total	**26**

Python for Mechanical Engineering Laboratory (DJS22MEL308)	
Exp.	**Suggested experiments**
1	To take input from user and print the sum, smaller no, larger no.
2	At least two programs involving operations related to basics of Python.
3	At least two programs related to Data handling and manipulation
4	Python applied to Mechanical Applications – At least 3

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.

Laboratory: (Term work)

Term work shall consist of minimum 7 experiments, 1 Mini Project.

The distribution of marks for term work shall be as follows:

i. Laboratory work (Performance of Experiments): 15 Marks

ii. Mini Project: 10 Marks

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

Books Recommended:

Reference Books:

1. Problem Solving and Programming; S. Kuppuswamy, S. Malliga, C.S. Kanimozhi Selvi, K. Kousalya; 2019; Tata McGraw Hill.
2. Introducing Python Modern Computing in Simple Packages; Bill Lubanovic; 1 st edition; 2014; O'Reilly Media.
3. Python: The Complete Reference; Martin C; 1 st edition; 2018; Tata MacGrawHill.
4. Core Python Programming; R. Nageswara Rao; 2 nd edition; 2018; DreamTech Press.
5. Let Us Python; Yashavant Kanetkar; 2019; BPB Publication.

Program: Mechanical Engineering	**S.Y B. Tech**	**Semester: III**
Course: Innovative Product Development I (DJS22A2)		

Objectives:

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

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

1. Identify the requirement for a product based on societal/research needs.
2. Apply knowledge and skills required to solve a societal need by conceptualizing a product, especially while working in a team.
3. Use standard norms of engineering concepts/practices in the design and development of an innovative product.
4. Draw proper inferences through theoretical/ experimental/simulations and analyze the impact of the proposed 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 III and IV.

Guidelines for Assessment of the work:

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

A candidate needs to secure a minimum of 50% marks to be declared to have completed the audit course.

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

- In the semester III, 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.

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

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

• The semester reviews 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 Examiners,

Sem IV

Program: Mechanical Engineering	**S.Y. B. Tech**	**Semester: IV**
Course: Engineering Mathematics-IV (DJS22MEC401)		
Course: Engineering Mathematics-IV Tutorial (DJS22MET401)		

Objectives:

1. To inculcate an ability to relate engineering problems to mathematical context.
2. To provide a solid foundation in mathematical fundamentals required to solve engineering problem.
3. To study the basic principles of linear algebra, vector analysis, probability, test of hypothesis and correlation between data.
4. To prepare students for competitive exams.

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

1. Identify diagonalizable and derogatory matrices and find functions of square matrices using eigenvalues and eigenvectors.
2. Understand concepts of solenoidal and conservative fields. Evaluate vector integrals.
3. Use probability to solve real-life engineering problems.
4. Draw conclusions on population based on large and small samples taken. Analyze the variances of multiple variables simultaneously.

Engineering Mathematics-IV (DJS22MEC401)		
Unit	**Description**	**Duration**
1	**Linear Algebra** **1.1** Characteristic equation, Eigenvalues and Eigenvectors with properties. **1.2** Cayley-Hamilton theorem to find higher order matrices and inverse of matrix. **1.3** Diagonalizability of similar matrices. **1.4** Functions of square matrix. **1.5** Quadratic Forms: Canonical form using congruent transformations, Orthogonal Transformation to find rank, index, signature and value class.	09
2	**Vector differentiation** **2.1** Scalar and vector point functions. Gradient of a scalar function, **2.2** Divergence, curl and Scalar Potential of a vector function. **2.3** Solenoidal, Irrotaional and conservative Fields.	06
3	**Vector Integration** **3.1** Line integrals **(For Self-Study)**, Green's theorem (without proof) for planes and verification of line integrals. **3.2** Stokes theorem and Gauss divergence theorem (without proof and verification).	04

4	**Probability** **4.1** Discrete and Continuous random variables, Probability mass and density function, Probability distribution for random variables, Expected value, Variance. **4.2** Probability Distributions: Binomial, Poisson, and Normal Distributions (for detailed study).	08
5	**Sampling Theory** **5.1 Sampling** distribution. Test of Hypothesis. Level of significance, critical region. One tailed and two tailed tests. Interval Estimation of population parameters. Large and small sample. **5.2** Test of significance for large samples: Test for significance of the difference between samples mean and population means, Test for significance of the difference between the means of two samples. **5.3** Student's t-distribution and its properties. Test of significance of small samples: Test for significance of the difference between samples mean and population means, Test for significance of the difference between the means of two Samples, paired t-test. **5.4** Chi-square test, Test for the Goodness of fit, Association of attributes.	09
6	**ANOVA (For Self-Study)** **6.1 Analysis** of Variance (F-Test): One-Way classification, Two-way classification (short-cut method).	03
	Total	**39**

Engineering Mathematics - IV Tutorial (DJS22MEC401)	
Tut.	**Suggested Tutorials**
1	Eigen Values and Eigen Vectors.
2	Cayley-Hamilton Theorem, Linear independence of Eigen vectors.
3	Similarity of Matrices and diagonalization.
4	Functions of square Matrices
5	Quadratic forms.
6	Random Variables, Expectation, Variance.
7	Binomial distribution, Poisson distribution.
8	Normal distribution.
9	Sampling- (Z- test).
10	Sampling- (t- test).
11	Chi square distribution.
12	ANOVA.

Tutorials:

Minimum eight tutorials based on syllabus will be conducted. A mini project relevant to the subject may be included, which would help the learner to apply the concept learnt.

Books Recommended:

Textbooks:

1. Higher Engineering Mathematics, Dr B. S. Grewal, Khanna Publication
2. Advanced Engineering Mathematics, E Kreyszing, Wiley Eastern Limited

References:

1. Higher Engineering Mathematics, B.V. Ramana, McGraw Hill Education, New Delhi
2. Integral Transforms and their Engineering Applications, Dr B. B. Singh, Synergy Knowledge ware, Mumbai
3. Numerical Methods, Kandasamy, S. Chand & CO
4. Fundamentals of Mathematical Statistics by S.C. Gupta and Kapoor

Program: Mechanical Engineering	S.Y B.Tech	Semester: IV
Course: Fluid Mechanics (DJS22MEC402)		
Course: Fluid Mechanics Laboratory (DJS22MEL402)		

Objectives:

1. To study fluid statics and fluid dynamics.
2. To study application of mass, momentum and energy equations in fluid flow.
3. To learn various flow measurement techniques.

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

1. **Explain** the key fluid properties, *calculate* the pressure, hydrostatic pressure force.
2. **Identify** various flow characteristics based on the velocity field and *determine* the streamline pattern and acceleration field given a velocity field.
3. **Explain** the development, uses, and limitations of the Bernoulli equation and *analyze* certain types of flows using the Navier–Stokes equations.
4. **Identify** and understand various characteristics of the flow in pipes, *calculate* losses in straight portions of pipes as well as those in various pipe system components, apply appropriate equations and principles to analyze a variety of pipe flow situations.
5. **Explain** the fundamental characteristics of a boundary layer, including laminar, transitional, and turbulent regimes, *calculate* boundary layer parameters for flow past a flat plate.
6. **Understand** some important features of different categories of compressible flows of ideal gases, *solve* useful problems involving isentropic and non-isentropic flows.

Fluid Mechanics (DJS22MEC402)		
Unit	**Description**	**Duration**
1	**Fluid Statics:** Definition of fluid, fluid properties such as viscosity, vapour pressure, compressibility, surface tension, capillarity etc. pressure at a point in the static mass of fluid, variation of pressure, Pascal's law, pressure measurement by simple and differential manometers. Hydrostatic forces on the plane and curved surfaces.	**7**
2	**Fluid Kinematics:** Eulerian and Lagrangian approach to solutions; Velocity and acceleration in an Eulerian flow field; Definition of streamlines, path lines and streak lines; types of fluid flows; Definition of control volume and control surface, circulation, vorticity. Understanding of differential and integral methods of analysis. Definition and equations for stream function, velocity potential function in rectangular co-ordinates, rotational and irrotational flows.	**6**

3	**Integral Relations for a Control Volume:** Basic Physical Laws of Fluid Mechanics, The Reynolds Transport Theorem, Conservation of Mass, The Linear Momentum Equation, Frictionless Flow: The Bernoulli's equation, Navier-Stokes equations (without proof) in rectangular Cartesian co-ordinates; Exact solutions of Navier-Stokes Equations to viscous laminar flow between two parallel planes (Couette flow and plane Poiseuille flow)	**7**
4	**Real fluid flows:** Definition of Reynold's number, Laminar flow through a pipe (Hagen-Poiseuille flow), velocity profile and head loss; Turbulent flows, Prandtl mixing length theory; velocity profiles for turbulent flows universal velocity profile, Velocity profiles for smooth and rough pipes Darcy's equation for head loss in pipe (no derivation), Moody's diagram, pipes in series and parallel, major and minor losses in pipes.	**7**
5	**Boundary Layer Flows:** Concept of boundary layer and definition of boundary layer thickness, displacement, momentum and energy thickness; Growth of boundary layer, laminar and turbulent boundary layers, laminar sub-layer; Von Karman Momentum Integral equation for boundary layers (without proof), analysis of laminar and turbulent boundary layers, drag, boundary layer separation and methods to control it, streamlined and bluff bodies. **Aerofoil theory:** Definition of aerofoil, lift and drag, stalling of aerofoils, induced drag.	**6**
6	**Compressible Fluid flow:** Propagation of sound waves through compressible fluids, Sonic velocity and Mach number; Application of continuity , momentum and energy equations for steady state conditions; steady flow through nozzle, isentropic flow through ducts of varying cross-sectional area, Effect of varying back pressure on nozzle performance, Critical pressure ratio, Normal shocks, basic equations of normal shock, change of properties across normal shock.	**6**
	Total	**39**

Fluid Mechanics Laboratory (DJS22MEL402)	
Exp.	**Suggested experiments**
1	Flow measurement-using Venturimeter.
2	Flow measurement-using Orificemeter.
3	Flow measurement-using Rotameter.
4	Determination of friction factor for Pipes
5	Determination of major and minor losses in Pipe system.
6	Verification of Bernoulli's Theorem. (Bernoulli's Apparatus)
7	Experiment on Laminar flow in pipes (Reynolds Apparatus).
8	Verification of impulse momentum principle.
9	Flow over notches / weirs.

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.

A mini project relevant to the topics studied, which would help the learner to apply the concepts.

Books Recommended:

Text books:

1. Fluid Mechanics by R K Bansal
2. Introduction to Fluid Mechanics and Fluid Machines by S. K. Som and Gautam Biswas

Reference Books:

1. Fluid Mechanics by Frank W. White, McGraw Hill Education
2. Fluid Mechanics by Yunus A. Cengel and John M Cimbala, McGraw Hill Education, 3rd Edition
3. Fundamentals of Fluid Mechanics by Bruce Munson, John Wiley and sons
4. Introduction to Fluid Mechanics by Fox and McDonald, John Wiley and sons
5. Fluid Mechanics by Victor Streeter, Benjamin Wylie and K W Bedford, McGraw Hill Education, 9th Edition
6. Mechanics of Fluids by Merle Potter, Cengage Learning
7. Engineering Fluid Mechanics by Donald F. Elger, John Wiley and sons
8. Fluids Mechanics by Russel C. Hibbeler, Prentice Hall

Program: Mechanical Engineering	S.Y. B. Tech	Semester: IV
Course: Kinematics of Machinery (DJS22MEC403)		
Course: Kinematics of Machinery Laboratory (DJS22MEL403)		

Objectives:

1. To become acquainted with basic concept of kinematics and kinetics of machine elements
2. To acquaint oneself with various basic mechanisms and inversions
3. To study the basics of power transmission

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

1. Apply the principles of kinetics to solve problems involving rigid bodies.
2. Explain the working of various mechanisms and machines.
3. Determine the velocity and acceleration of the mechanism links.
4. Sketch motion graphs for a given follower motion.
5. Determine basic design parameters of belt drives and chain drives.
6. Determine basic design parameters of gears and gear trains.

Kinematics of Machinery (DJS22MEC405)		
Unit	**Description**	**Duration**
1	**Kinetics of Rigid Bodies:** Mass moment of Inertia, radius of gyration, rigid body kinetics - bodies in translating motion, rotation about fixed axis and in general plane motion	**04**
2	**Basic Kinematics:** Introduction, kinematic link & its types, kinematic pairs and types, types of constrained motions, kinematic chains, types of joints, degree of freedom (mobility), Kutzbach mobility criteria, Grubler's criteria & its limitations, four bar chain and its inversions, Grashoff's law, slider crank chain and its inversions, double slider crank chain and its inversions	**05**
3	**Velocity and Acceleration Analysis of Mechanisms** (mechanisms up to 6 links): Velocity analysis by instantaneous centre of rotation method and relative velocity method (Graphical approach), rubbing velocities at joints, mechanical advantage, Acceleration analysis by relative method including pairs involving Coriolis component (Graphical Approach)	**09**
4	**Cam Mechanism:** Fundamentals of cams and followers, classification of cams and followers, motion analysis and plotting of displacement - time, velocity-time, acceleration-time, jerk-time graphs for uniform velocity, UARM, SHM, and cycloid motions (combined motions during one stroke excluded)	**06**
5	**Power transmission drives:** **V-belt drive and rope drives:** Introduction, classification, materials used, construction, ratio of driving tensions, power transmission **Chains:** Chain terminology, relation between pitch and pitch circle diameter, classification of chains, chordal action, variation in velocity ratio, length of chain	**07**

6	**Gears and Gear Trains:** **Gears**- Introduction, gear terminology, types of gears, law of gearing, velocity of sliding, involute and cycloidal tooth profile, length of arc of contact, contact ratio, interference in involutes gears, critical numbers of teeth for interference free motion, methods to control interference in involutes gears, Static force analysis in spur gears. **Gear Trains:** Kinematic analysis of simple and compound gear trains, reverted gear trains, epi-cycle gear trains with spur gear combination	**08**
	Total	**39**

Kinematics of Machinery Laboratory (DJS22MEL405)	
Exp.	**Suggested experiments**
1	Study of Exact straight line generating mechanisms (Peaucillier's and Hart's mechanisms)
2	Study of Approximate straight line generating mechanisms (Watt's, Grasshopper and Tchebicheff's mechanisms)
3	Study of steering gear mechanisms (Ackerman and Davis steering gears)
4	Study of offset slider crank mechanisms – (Pantograph, single and double Hook-joint).
5	Analysis of velocity of mechanisms by Instantaneous Center of Rotation (3-5 problems)
6	Analysis of velocity of mechanism by Relative method (3-5 problems)
7	Analysis of acceleration of mechanism by Relative method (3-5 problems)
8	Plotting of displacement–time, velocity-time, acceleration-time and jerk-time graphs for cams and followers (3-5 problems)
9	Layout of cam profiles (3-5 problems)
10	Construction of Involute and Cycloid gear tooth profile - 2 problems

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

A mini project relevant to the subject may be included, which would help the learner to apply the concept learnt.

Books Recommended:

Text books:

1. Theory of Machines by S. S. Ratan, Tata McGraw-Hill Publishing Company Limited, New Delhi.
2. Theory of Machines by R. S. Khurmi, S. Chand & Comapany Limited, New Delhi.
3. Theory of Machines by P. L. Ballaney, Khanna Publishers, Delhi.

Reference Books:

1. Theory of Mechanisms and Machines by Amitabh Ghosh and A. Kumar Mallik, affiliated to East-West Press.

2. Theory of Machines and Mechanism by Uicker Jr, Garden Pennock & J.F. Shigley, Oxford University Press.
3. Mechanism Design: Analysis and Synthesis Vol I by A. Erdman and G N Sander, Prentice Hall.
4. Kinematics and Dynamics of Planer mechanisms by Jeremy Hirsihham, McGraw Hill.
5. Theory of Machines by W. G. Green, Bluckie & Sons Ltd.

Program: Mechanical Engineering	S.Y. B. Tech	Semester: IV
Course: Engineering Materials (DJS22MEC404)		
Course: Materials Testing Laboratory (DJS22MEL404)		

Objectives: The basic objective of this course is to nurture the participants with comprehensive understanding of engineering materials and related concepts.

1. To study basic engineering materials, their structures, properties, applications & selection.
2. To make the students familiarize with the concepts of material failure and failure analysis under different working environments.
3. To study the alloys, phase diagrams and rules, Iron –Iron carbide diagram, microstructural development.
4. To study heat treatment principles and alloying elements used in the development of materials with an engineering application.
5. To provide an insight for the latest developments in engineering materials and to know their needs and applications.

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

1. Classify engineering materials and illustrate related fundamental concepts such crystal structure, structure-property-processing-performance correlation, crystal defects, deformation mechanism and strengthening mechanisms.
2. Identify and comprehend failure modes of engineering materials and related issues.
3. Describe alloys and alloy phase diagrams, Iron-Iron Carbide based phase diagram, Microstructural development in steels and cast iron and demonstrate the application of phase rule and lever rule.
4. Select and justify the proper heat treatment process and alloying elements for steel in order to obtain desirable properties to suit application requirements.
5. Recognize the need for modern new age materials to cater the engineering application demands.

Engineering Materials (DJS22MEC305)		
Unit	**Description**	**Duration**
1	**Introduction to Engineering Materials** 1.1 Introduction to solid engineering materials, their classification and properties, crystal structures, crystal defects and their significance. 1.2 Deformation in crystalline material – Elastic and Plastic deformation, Slip and twin mechanism, Slip systems and their contribution, Critical resolved shear stress 1.3 Strain hardening - Mechanism and its effect, dislocation interaction, frank reed source of dislocation generation 1.4 Recrystallization Annealing and other strengthening mechanisms	**03**
2	**Materials Failure** 2.1 General classification of fracture modes, ductile and brittle fracture mechanism (including stress-strain diagram and microstructural aspects)	**04**

	2.2 Metallurgical significance of Ductile- Brittle Transition Temperature, Griffith's theory of brittle fracture and Orowan's modification, fracture toughness. 2.3 Fatigue Failure: Definition, examples, type of fluctuating stress, experimental set up for fatigue test, S-N Curve and its interpretation, Macroscopic and microscopic characteristic, factors influencing fatigue, Fatigue failure prevention, Concept of thermal fatigue, corrosion fatigue and static fatigue. 2.4 Creep Failure: Definition and examples of creep, high temperature behavior and mechanism of creep, Creep testing, Creep curve, effect of stress and temperature on creep curve, Creep Resistant materials.	
3	**Alloys and Alloy Phase Diagrams** 3.1 Mechanism of solidification – Nucleation and growth of crystal, necessity of alloying, Interstitial and Substitutional solid solutions, Hume Rothery rule, types alloys, 3.2 Alloy phases and Construction of phase diagrams (unary, binary, ternary, Isomorphous etc), Gibb's phase rule for condensed phases, application of tie line and lever rule, Invariant reactions, Polymorphism in Iron etc. 3.3 Specific study of Iron –Iron Carbide Phase diagram - Construction, Important Phases, Compositions and Critical Temperatures 3.4 Slow cooling behavior and microstructural development 3.5 Plain carbon steels and Cast Irons	**05**
4	**Heat Treatment Principles and Techniques in Steel** 4.1 Heat treatment purpose, process & environment, microstructure, properties and applications of – Annealing & its types, normalizing, quenching, tempering & its stages, Martempering and Maraging 4.2 Construction of TTT and CCT diagram and its engineering significance 4.3 Hardenability and Jominy End Quench Test 4.4 Case Hardening Treatments – Carburizing, Nitriding and Carbonitriding etc 4.5 Surface Hardening Treatments – Flame and Induction Hardening etc.	**04**
5	**Effect of Alloying Elements on Structure and Properties of steel** 5.1 Alloying elements in steels and cast iron and their effects, Ferrite Stabilizers, Austenite Stabilizers and strong carbide forming elements 5.2 Stainless Steel and High Speed Steel: Composition, Properties, types and applications 5.3 Effect of alloying element on Fe-Fe_3C , TTT, CCT diagram and Hardenability	**04**
6	**Introduction to New Age Materials** Polymers, Ceramics, Composites, Nanomaterials, Smart Materials, energy materials, light metals and alloys: Need of these materials, their types, properties and applications.	**06**
	Total	**26**

Materials Testing Laboratory (DJS22MEL305)	
Exp.	**Suggested experiments**
1	Study and demonstration of metallurgical/optical microscope (Trinocular)
2	Specimen/Sample preparation for metallography
3	Study of microstructures of plain carbon steels
4	Study of microstructures of Cast Irons
5	To carry out heat treatment process (Annealing, Normalizing and Hardening) of medium carbon steel and observation of changes in microstructure and properties
6	Study of tempering characteristics of hardened steel
7	To determine the hardenability of steel by conducting Jominy-End Quench test
8	Fatigue test – to determine number of cycles to failure of a given material at a given stress

Minimum Six experiments from the above list.

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

Assignments:

Minimum five assignments based on syllabus

(OR)

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

(OR)

Case study based seminar

Books Recommended:

Text books:

1. Materials Science and Engineering: An Introduction, 10th Edition, William D. Callister, David G. Rethwisch, John Wiley and Sons, 2020.
2. Physical Metallurgy: Principles and Practice, 2nd Edition, V Raghavan, PHI Learning Pvt. Ltd., 2009.
3. Introduction to Physical Metallurgy, S. H. Avner, Mc Graw Hill, 2017.
4. Engineering Materials Technology, 3rd Edition, W. Bolton, Oxford [England]: Butterworth-Heinemann, 2001.
5. Nano Materials, 2nd Edition, A.K. Bandopadhyay, New age international publishers, 2010.
6. Engineering Materials (Properties and applications of metals and alloys), C.P. Sharma, 2004.

Reference Books:

1. Experimental Techniques in Materials and Mechanics, by C. Suryanarayana, CRC press, Taylor & Francis Group, 2011.
2. Mechanical Metallurgy, 3rd Edition, G. E. Dieter, McGraw Hill International New Delhi, 2017.
3. Essentials of Materials Science and Engineering, 3rd Edition by Donald R Askeland, Wendelin J Wright, Cengage Learning, 2013.

4. Composite Materials – Science and Engineering, 3rd Edition, Krishnan K. Chawla, Springer, 2013.
5. Composites Manufacturing – Materials, Product, and Process Engineering, Sanjay K. Muzumdar, CRC Press, 2002.
6. Materials for Engineers and Technicians, 6th Edition, W. Bolton, R.A. Higgins, Routledge, 2015.
7. Engineering Materials, Henry Tindell, The Crowood Press ltd., 2014.
8. The Science and Engineering of Materials, 7th Edition by Donald R. Askeland, Wendelin J Wright, Cengage Learning, 2015.
9. Engineering Materials and Metallurgy, R. K. Rajput, S. Chand and Company Ltd., 2006.
10. Heat Treatment: Principles and Techniques, 2nd edition, T.V. Rajan, C.P. Sharma, and Ashok Sharma, PHI Learning Pvt Ltd., 2011.
11. Computational Material Science, June Gunn Lee, CRC Press, 2011.
12. Advanced Structural Materials, Winson O Soboyejo, T.S. Srivatsan, CRC press, Taylor and Francis Group, 2011.

Program: Mechanical Engineering	S.Y. B. Tech	Semester: IV
Course: Advanced Manufacturing Processes (DJS22MEC405)		

Objectives:

1. To acquaint the knowledge of additive manufacturing processes, and its capabilities in themodern digital manufacturing industry.
2. To familiarize the students with unconventional modern machine tools & manufacturingpractices.
3. To familiarize oneself with various micro manufacturing techniques like Meso, Micro and Nano.

Outcomes: learner will be able to:

1. Understand the fundamentals of various non-conventional machining processes, and their capabilities with their application areas.
2. Understand MEMS and Non-MEMS based manufacturing techniques.
3. Understand the various Nano finishing techniques.
4. Reviewing the difference between traditional and additive manufacturing techniques.
5. Understand and apply the fundamental principles of various Additive Manufacturing (AM) technologies in solid based, liquid-based and powder-based techniques.

Advanced Manufacturing Processes (DJS22MEC405)		
Unit	**Description**	**Duration**
01	**Unconventional machining processes:** Classification of the Non-traditional machining process. Basic principles, machines, advantage, disadvantages, and applications of Electrical discharge machining (EDM), Electron beam machining (EBM), Plasma arc machining (PAM), Laser beam machining (LBM), Electrochemical machining (ECM), Chemical machining (CHM), Ultrasonic machining (USM), Abrasive jet machining (AJM), Water jet machining (WJM), Abrasive water jet machining (AWJM). **Introduction to Hybrid machining.**	06
02	**MEMS Micro Manufacturing** Challenges in Meso, Micro, and Nano manufacturing, Overview about micro fabrication methods - Chemical vapour deposition (CVD); Physical vapour deposition (PVD), optical and electron beam lithography; Dry and wet etching. **NON – MEMS Micro Machining** Mechanics of micro machining, Difference between micro and macro machining Micro turning, Micro Milling, Micro grinding.	05
03	**Nano Finishing Techniques** Abrasive Flow Machining (AFM), Magnetic Abrasive Finishing (MAF), Magneto rheological Finishing (MRF), Magneto rheological Abrasive Flow Finishing (MRAFF), Magnetic Float Polishing (MFP), Elastic Emission Machining (EEM), Chemical Mechanical Polishing (CMP).	05

04	**Introduction to Additive Manufacturing (AM)** Introduction to AM History, Traditional manufacturing v/s Additive Manufacturing, Discussion on different materials used in AM, Role of solidification rate in AM, Grain structure and microstructure in AM. **Extrusion based AM processes:** Fused deposition Modeling (FDM), history of FDM, basic principle, material requirements, benefits and limitations, post-processing. Other extrusion based systems: extrusion of: ceramics, metals, biomaterials, composites, contour crafting, concrete printing.	04
05	**Powder Bed Fusion AM Process:** Selective Laser Sintering (SLS): process workflow and material requirements, powder fusion mechanism, polymer ageing and recycling. Other powder fusion systems: selective laser melting, electron beam melting.	03
06	**Vat Polymerization AM process:** Stereo lithography apparatus (SLA), history of SLA, material requirements, workflow, scan patterns, applications, benefits and limitations. Other liquid polymer-based systems: Solid Ground Curing (SGC), Digital Light Processing (DLP), Continuous Liquid Interface Production (CLIP).	03
	Total	**26**

Books Recommended:

Reference Books:

1. Additive manufacturing technologies: rapid prototyping to direct digital manufacturing, by IanGibson, David W. Rosen, Brent Stucker, Springer, 2010.
2. Understanding additive manufacturing: rapid prototyping, rapid tooling, rapid manufacturing,by Andreas Gebhardt, Hanser Publishers, 2011.
3. Emerging Nanotechnologies for Manufacturing, by Waqar Ahmed, Mark J. Jackson, 2ndEdition, Elsevier, 2015.
4. Introduction to Micromachining by Jain V. K. Narosa Publishing House, 2010.
5. Micro and Nano-manufacturing, by Mark J. Jackson, Springer, 2007.
6. Micromachining of Engineering Materials, by Joseph McGeough (Editor), Marcel Dekker,2002.
7. Micro-Manufacturing Engineering and Technology, by Yi Qin, Elsevier, 2010.
8. A Text Book of Production Technology Vol.II by O. P. Khanna, Dhanpat Rai Publication, 2000.

Program: Mechanical Engineering	S.Y. B. Tech	Semester: IV
Course: Mechanical Measurements and Metrology (DJS22MEC406)		
Course: Mechanical Measurements and Metrology Laboratory (DJS22MEL406)		

Objectives:

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

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

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

Mechanical Measurements and Metrology (DJS22MEC406)		
Unit	**Description**	**Duration**
1	**Introduction to mechanical measurements and metrology:** Significance of Mechanical Measurements, Classification of measuring instruments, generalized measurement system, types of inputs: Desired, interfering and modifying Inputs. Static characteristics: Static calibration, Linearity, Static Sensitivity, Accuracy, Static Error, Precision, Reproducibility, Threshold, Resolution, Hysteresis, Drift, Span & Range etc. Introduction to Metrology: Fundamental Definitions, Types of Standards, Precision and Accuracy, Errors in measurement: Types of errors, Effect of component errors, Probable errors.	8
2	**Displacement Measurement**: Transducers for displacement, displacement measurement, potentiometer, LVDT, Capacitance Types, Digital Transducers (optical encoder), Nozzle, Flapper Transducer Strain Measurement: Theory of Strain Gauges, gauge factor, temperature Compensation, Bridge circuit, orientation of strain gauges for force and torque, Strain gauge-based load cells and torque sensors.	6
3	**Pressure Measurement:** Mechanical Pressure-Measurement Devices, High Pressure Measurements, Bridge man Gauge. Vacuum measurement: Vacuum gauges viz. McLeod gauge, Ionization and Thermal Conductivity gauges. Flow Measurement: Ultrasonic Flow meter, Magnetic flow meter, The Laser Doppler Anemometer and Hot-Wire and Hot-Film Anemometers. Temperature Measurement: Electrical methods of temperature measurement Resistance thermometers, Thermistors and thermocouples and Pyrometers.	7

4	**Linear measurements, Angular Measurement** Design of Gauges: Limits, Fits, Tolerances, Types of Gauges, Taylor's Principle of Limit Gauges, IS 919 for design of gauges. Gear Measurement by Parkinson Gear tester and Gear tooth Vernier Caliper, Screw Thread Measurement: Effective diameter measurement of screw thread by Floating Carriage micrometer.	8
5	**Surface Texture measurement:** Surface roughness, Waviness, Roughness Parameter Ra, Rz, RMS etc., working of Tomlinson surface meter, Tally-surf surface roughness tester, Surface roughness symbols.	5
6	**Advances in metrology:** Basic concepts of lasers, advantages of lasers, laser interferometers, types, applications. Basic concepts of Coordinate Measuring Machines-constructional features, applications.	5
	Total	**39**

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

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

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

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

Mechanics of Materials Laboratory (DJS22MEL406)	
Exp.	**Suggested experiments**
1	Dead Weight Pressure gauge
2	Calibration of Vacuum Gauges
3	Study of strain gauges
4	Torque measurement using strain gauges
5	Study of Linear Variable Differential Transformer
6	Speed Measurement using tachometer, optical and magnetic pickup
7	Study of Vernier Caliper, Micrometer.
8	Gear measurement using Gear tooth Vernier caliper
9	Thread Measurement using Floating carriage micrometer

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

Assignments:

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

Books Recommended:

Text books:

1. Mechanical Engineering Measurements, A K Sawhney, Dhanpat Rai& Sons, New Delhi.
2. Instrumentation & Mechanical Measurements, A K Thayal
3. Engineering Metrology, K.J. Hume, Kalyani Publications
4. A text book of Engineering Metrology, I.C. Gupta, Dhanpat Rai Publications
5. Engineering Metrology and Measurements, Bentley, Pearson Education

Reference Books:

1. Measurement Systems: Applications and Design, by EO Doebelin,5th Edition, McGraw Hill
2. Instrumentation and Control System, W. Bolton, Elsevier
3. Mechanical Measurements, S P Venkateshan, Ane books, India
4. Mechanical Measurements and Metrology, R K Jain, Khanna Publishers
5. Metrology and Measurement, Anand,Bewoor and VinayKulkarni, McGraw Hill
6. Engineering Metrology and Measurement, N V Raghavendra and Krishnamurthy, Oxford University Press.

Program: Mechanical Engineering	**S.Y B. Tech**	**Semester: IV**
Course: Advance Manufacturing Processes Laboratory (DJS22MEL407)		

Objectives:

1. Practice writing complex "G" code programs for CNC turning centers that meet the part specification.
2. To Interpret and demonstrate complex "G" code programs for CNC milling centers that meet the part specification.
3. To know the importance of 3D printing in Manufacturing and gain skills related to 3D printing technologies.
4. To understand the various software tools, process, and techniques for manufacturing complex profiles using 3D Printing Technologies.
5. Evaluate manufacturing assignment based on critical thinking and problem-solving skills. Become a good communicator and effective team member.

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

1. Demonstrate the various CNC control and calculate technological data for CNC machining.
2. Prepare programs, demonstrate, simulate, and operate CNC machines for various machining operations.
3. Apply engineering knowledge, techniques, and modern tools to analyze problems in additive manufacturing.
4. Develop a working model using additive manufacturing (3D Printing) Processes.
5. Engage in lifelong learning adhering to professional, ethical, legal, safety, environmental and societal aspects for career excellence.

Exp.	**Experiments**
01	Introduction to CNC lathe and CNC milling, use of measuring instruments, coordinate system, CNC controller, MDI, Offset measurement, simulation of programs. Practicing various turning cycles like OD/ID turning, grooving, threading etc. and canned cycles like drilling, reaming, boring etc.
02	Preparing a 3D model, simulating, and generating G and M codes on any software (Pro-e, UG NX, CREO, Fusion 360, etc.)
03	One job involving programming, simulation, and fabrication of the component on a CNC Turning centre.
04	One job involving programming, simulation, and fabrication of the component on a CNC Vertical Machining centre.
05	Generating STL files from the CAD (Computer Aided Design) model.
06	Processing and Simulation of process parameters in CURA Software for optimizing build-time and material consumption.
07	Fabricating the component by additive manufacturing.

Books Recommended:

Reference Books:

1. Workshop Technology, W. A. J. Chapman Vol I & II
2. Workshop Technology, Hazra Choudhary Vol. I & II
3. Additive Manufacturing Technologies, Ian Gibson, D.W. Rosen, and B. Stucker, 2nd Edition, Springer 2015

Program: Mechanical Engineering	**S.Y B.Tech**	**Semester: III**
Course: Constitution of India (DJS22A3)		

Objectives:

1. To provide basic information about Indian constitution.
2. To identify individual role and ethical responsibility towards society.
3. To understand human rights and its implications.

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

1. Have general knowledge and legal literacy and thereby take up competitive examinations.
2. Understand state and central policies, fundamental duties.
3. Understand Electoral Process, special provisions.
4. Understand powers and functions of Municipalities, Panchayats and Co-operative Societies.
5. Understand Engineering ethics and responsibilities of Engineers.
6. Understand Engineering Integrity & Reliability.

Constitution of India (DJS22A3)		
Unit	**Description**	**Duration**
1	**Introduction to the Constitution of India:** The Making of the Constitution and Salient features of the Constitution. Preamble to the Indian Constitution Fundamental Rights & its limitations.	**2**
2	**Directive Principles of State Policy:** Relevance of Directive Principles State Policy Fundamental Duties. Union Executives – President, Prime Minister Parliament Supreme Court of India.	**3**
3	**State Executives:** Governor, Chief Minister, State Legislature High Court of State. Electoral Process in India, Amendment Procedures, 42nd, 44th, 74th, 76th, 86th & 91stAmendments.	**2**
4	**Special Provisions:** Provisions for Backward class section of society, Provision for Women, Children & Backward Classes Emergency Provisions	**2**
5	**Human Rights:** Meaning and Definitions, Legislation Specific Themes in Human Rights- Working of National Human Rights Commission in India, Powers and functions of Municipalities, Panchayats and Co–Operative Societies.	**2**
6	**Scope & Aims of Engineering Ethics:** Responsibility of Engineers Impediments to Responsibility. Risks, Safety and liability of Engineers, Honesty, Integrity & Reliability in Engineering	**2**
	Total	**13**

Books Recommended:

Text books:

1. Introduction to the Constitution on India, (Students Edn.) by Durga Das Basu: Prentice –Hall EEE, 19th / 20th Edn., 2001.
2. Engineering Ethics, by Charles E. Haries, Michael S Pritchard and Michael J. Robins Thompson Asia, 2003-08-05.

Reference Books:

1. An Introduction to Constitution of India, by M. V. Pylee, Vikas Publishing, 2002.
2. Engineering Ethics, by M. Govindarajan, S. Natarajan, V. S. Senthilkumar, Prentice – Hall of India Pvt. Ltd. New Delhi, 2004.
3. Introduction to the Constitution of India, by Brij Kishore Sharma, PHI Learning Pvt. Ltd., New Delhi, 2011.
4. Latest Publications of Indian Institute of Human Rights, New Delhi

Program: Mechanical Engineering	**S.Y B. Tech**	**Semester: IV**
Course: Innovative Product Development II (DJS22A4)		

Objectives:

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

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

1. Identify the requirement for a product based on societal/research needs.
2. Apply knowledge and skills required to solve a societal need by conceptualizing a product, especially while working in a team.
3. Use standard norms of engineering concepts/practices in the design and development of an innovative product.
4. Draw proper inferences through theoretical/ experimental/simulations and analyze the impact of the proposed 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 III and IV.

Guidelines for Assessment of the work:

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

In the last review of the semester IV, the marks will be awarded as follows.

- Marks awarded by the supervisor (Considering technical paper writing): 30
- Marks awarded by the review committee : 20

A candidate needs to secure a minimum of 50% marks to be declared to have completed the audit course.

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

- In the semester IV, 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 III.
    - 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 IV. This review will also look at the readiness of the proposed technical paper presentation of the team.

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

1. Quality of survey/ need identification of the product.
2. Clarity of Problem definition (design and development) based on need.
3. Innovativeness in the proposed design.
4. Feasibility of the proposed design and selection of the best solution.
5. Cost effectiveness of the product.

6. Societal impact of the product.
7. Functioning of the working model as per stated requirements.
8. Effective use of standard engineering norms.
9. Contribution of each individual as a member or the team leader.
10. Clarity on the write-up and the technical paper prepared.

• The semester reviews 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 IV. Students are required to present the outline of the technical paper prepared by them during the final review in semester IV.