

# GUJARAT TECHNOLOGICAL UNIVERSITY

M.E Semester: 1

**Mechanical Engineering (CAD/CAM)**

Subject Name    Advanced Machine Design

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Sr.No	Course content
1.	General design procedure for design problems, design concepts, product design and development, Product design specifications, Product life cycle, Protection of intellectual property, Bench marking, Brainstorming, Ethics in Engineering design, Whistle blowing.
2.	Design for strength & rigidity.
3.	Design based on - Fatigue, Fracture, Creep criteria, safe life v/s fail safe design.
4.	Dynamic design of Mechanical equipments: Modelling of machine tools, Aircraft and Automobiles etc. for determining dynamic characteristics and extraction of Modal parameters for dynamic design.
5.	Design for manufacturing including assembly aspects & other aspects, reliability based design of mechanical components.
6.	Recent developments in pressure vessel design, testing of pressure vessels as per standards. Computer aided design of pressure vessels
7.	Rotating disc and rotating cylinder:- Disc with uniform thickness – disc for uniform strength – stresses in rotating cylinders with and without internal pressure.
8.	Thermal stress, creep and stress rupture; Dynamic and fatigue behaviour
9.	Friction theories, wear & types of wear, Lubrication, different modes of lubrication -hydrodynamic, hydrostatic & Elasto-Hydrodynamic, porous bearings, determination of static load capacity of bearing (Stribek's equation), bearing design & testing. Lubrication problems at certain extreme environmental conditions pressure, temperature & vacuum
10.	Recent trends in materials handling equipment design, basic principles of design, main girder design, structure analysis , loading patterns, service factors & environmental conditions, testing as per BIS, etc.
11.	Advances in gear design, gear materials, corrective gear design, gear rating calculation as per BIS, etc
12.	Quality Function Deployment – Concurrent engineering

## **Reference Books:**

1. Machine Design – An Integrated Approach by Robert L Norton, Pearson Education.
2. Mechanical System Design by Farzad Haidery.
3. Engineering Design by George E. Dieter, McGraw Hill.
4. Material handling equipment by P.Rudenko, MIR Publication.
5. Handbook of Gear design by G.M. Maitra, vol. –I & II.
6. Mechanical analysis & design by Burr and Cheatham.
7. Mechanical Vibrations by S.S.Rao.
8. Pressure Vessel Design by Bednar.
9. Process Equipment Design by Joshi.

# GUJARAT TECHNOLOGICAL UNIVERSITY

M.E Semester: 1

**Mechanical Engineering (CAD/CAM)**

Subject Name Computer Aided Machine Design

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Sr.No	Course content
1.	Introduction: Need and Scope of Computer Aided Machine Design
2.	Computer graphics: Principles of interactive computer graphics and overview of hardware available for use in CAD; Scan conversion; Bresenham's Algorithm for line, circle, Geometric transformations- 2D and 3D translation, scaling, rotation, shear and reflection, homogeneous transformations
3.	Geometric modelling: Types of mathematical representation of curves, wire frame models wire frame entities parametric representation of synthetic curves Hermit cubic splines Bezier curves, B-splines rational curves. Representations : B-rep and C-rep, Feature based modelling.
4	Surface modeling :Mathematical representation surfaces, Surface model, Surface entities surface representation, Parametric representation of surfaces, plane surface, rule surface, surface of revolution, Tabulated Cylinder.
5	Geometric modelling-3D: Solid modeling, Solid Representation, Boundary Representation (B-rep), Constructive Solid Geometry (CSG).
6	Solid modeling using software: Solid modeling of components and Assembly using CAD software such as ProEngineer/Inventor Professional / Mechanical Desktop
7	Computer aided design of machine components: To develop computer programs using 'C' / 'C++' / MATLAB Programming language for the machine components such as shafts, springs, couplings, clutches, brakes, levers, gears, belts
8	Engineering optimization: Optimum design of Machine Elements, Johnson's method, single variable and multi variable optimization techniques. Single objective and Multi-objective functions related to machine component design

## REFERENCE BOOKS:

1. CAD/CAM Theory and Practice by Ibrahim Zeid & R.Sivasubramanian, Tata Mc Graw Hill international.
2. Geometric Modelling, Mortenson, M.E., John Wiley & Sons, NY, 1985.
3. David F. Rogers and J. Alan Adams, "Mathematical Elements for Computer Graphics", McGraw-Hill.
4. Mastering CAD/CAM / Ibrahim Zeid / Mc Graw Hill international. CAD/CAM / P.N. Rao / TMH.
5. Engineering Optimization by S.S.Rao.
6. Engineering Optimization by Kalyanmoy Deb.
7. Design of Machine Elements by C.S. Sharma & Kamlesh Purohit, PHI Publications.

# GUJARAT TECHNOLOGICAL UNIVERSITY

M.E Semester: 1

**Mechanical Engineering (CAD/CAM)**

Subject Name Computer Aided Production Management

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Sr.No	Course content
1.	Computer Aided Forecasting : Nature and use of forecast, sources of data, demand patterns, forecasting methods – Delphy’s method, Time series method, exponential smoothing, linear regression, Box Jerkin’s method, ,selection of forecasting technique, measurement of forecast Accuracy-MAD, Adoptive methods
2.	Computerized relative allocation of facility technique, automated layout design program and computerized relationship layout planning for facility location and layout
3.	Group Technology: - Introduction, objectives part families, algorithms and models for G.T. - Rank order clustering, Bond energy, mathematical model for machine – component cell formation. Design and manufacturing attributes. Parts classification and coding, concept of composite job machine group, cell group tooling, design rationalization, CAD/CAM and GT benefits.
4	Computer Aided Process Planning: Generative and variant types, backward and forward approach, feature based and CAD based CAPP, Operation Management.
5	MRP: Introduction, Objective, Input, Computational procedure, information provided by the system. Detailed capacity planning, manufacturing resources planning.
6	ERP: Introduction, main features, generic model of ERP system, selection of ERP, proof of concept approach, analytic hierarchy approach, ERP implementation
7	Job Sequencings, scheduling
8	SHOP FLOOR CONTROL: Data collection, computer generated time standard
9	COMPUTER AIDED INSPECTION: Computer Aided Testing, Contact type, non-contact type.
10	SIMULATION: Major activities, purpose, simulation process, types methodology, simulation packages, process quality simulator, computer requirements trends, applications simulation of machine shop.

## REFERENCE BOOKS:

1. Computer Aided Manufacture by Chien Chang and Richard A Wysk, Prentice Hall.
2. CAD / CAM by M.P. Groover & Zimmers.
3. G.T. in the engineering industry Bur bridge.
4. Modern Production Management – Buffa & Sarin.
5. Computer Aided Production Management – P.B.Mahapatra.
6. Production Operation Management – Adam Ebert.
7. CAD / CAM / CIM by P. Radhakrishnan, S. Subramanyan, New Age International.

# GUJARAT TECHNOLOGICAL UNIVERSITY

M.E Semester: 1

**Mechanical Engineering (CAD/CAM)**

Subject Name    Advanced Materials And Processes

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Sr.No	Course content
1.	ADVANCED MATERIALS:Super alloys, Ferro electric and piezoelectric materials, Advanced magnetic materials, Advanced engineering polymer materials, Advanced ceramic and composite materials, photo conducting and photovoltaic materials, electro-optic materials, Lasers, smart materials
2.	PROCESSING OF MATERIALS:Conventional processing techniques for advanced materials, special processing techniques, use of computers in metal processing
3.	CHARACTERIZATION AND EVALUATION TECHNIQUES:Destructive and Non-destructive evaluation techniques, Electron and X-ray techniques, Distortion and Residual stress measurement.
4	PERFORMANCE OF MATERIALS IN SERVICE:Service performance, corrosion and its control, Delayed fracture, Performance of materials at High & low temperatures, Radiation damage and recovery.
5	DESIGN:Introduction :Design philosophy – steps in Design process – General Design rules for manufacturability – basic principles of designing for economical production – creativity in design.
6	MATERIALS: Selection of Materials for design – Developments in Material technology –criteria for material selection – Material selection interrelationship with process selection – process selection charts
7	MACHINING PROCESS: Overview of various machining processes – general design rules for machining - Dimensional tolerance and surface roughness – Design for machining – Ease – Redesigning of components for machining ease with suitable examples. General design recommendations for machined parts
8	METAL CASTING: Appraisal of various casting processes, selection of casting process, - general design considerations for casting – casting tolerances – use of solidification simulation in casting design – product design rules for sand casting
9	METAL JOINING: Appraisal of various welding processes, Factors in design of weldments – general design guidelines – pre and post treatment of welds – effects of thermal stresses in weld joints – design of brazed joints
10	FORGING:Design factors for Forging – Closed die forging design – parting lines of dies – drop forging die design – general design recommendations .
11	EXTRUSION & SHEET METAL WORK:Design guidelines for extruded sections - design principles for Punching, Blanking, Bending, Deep Drawing – Keeler Goodman Forming Line Diagram – Component Design for Blanking
12	PLASTICS: Viscoelastic and creep behavior in plastics – Design guidelines for Plastic components – Design considerations for Injection Moulding – Design guidelines for machining and joining of plastics

### **Reference Books:**

1. Design for Manufacture / John Cobert / Adisson Wesley, 1995.
2. ASM Handbook, Vol.20.
3. Engineering Design- A Material and Processing Approach / George E. Deiter / McGraw Hill Intl., 2nd Edition, 2000.
4. Product design and Manufacturing / A.K Chitale and R.C Gupta / Prentice – Hall of India, New Delhi, 2003.
5. Design and Manufacturing / Surender Kumar & Goutham Sutradhar / Oxford &IBH Publishing Co. Pvt .Ltd., New Delhi, 1998.

# GUJARAT TECHNOLOGICAL UNIVERSITY

M.E Semester: 1

**Mechanical Engineering (CAD/CAM)**

Subject Name Material Science and Materials

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Sr.No	Course content
1.	STRUCTURE – PROPERTY RELATIONSHIP : Atomic structure & Chemical bonding, Crystalline & Network structure, Grain structure, Grain deformation & Anisotropic properties, Properties of material, Physical, Chemical, Electrical, Thermal & Mechanical.
2.	THERMAL PROPERTIES OF MATERIALS : Specific Heat: Classical, Einstein, Debye theory, Anharmonic crystal imperfections, Electronic specific heat, Thermal Expansion, Hypothetical & Actual Energy Curves. Thermal Conductivity, Wridemann – Franz ratio.
3.	PERFORMANCE OF MATERIALS IN SERVICE :Performance based on - static properties, dynamic properties and temperature effect. methods of testing & interpretation of test results.
4	THEORY OF ELASTICITY AND PLASTICITY: Fundamentals- Methods - Yield surface.
5	ADVANCED MATERIALS:Super alloys, Ferro electric and piezoelectric materials, Advanced magnetic materials, Advanced engineering polymer materials, Advanced ceramic and composite materials, photo conducting and photovoltaic materials, electro-optic materials, Lasers, smart materials. Bio-materials – Determining mechanical properties and their applications. Recent trends in Bio-Material Characterization.
6	PROCESSING OF MATERIALS:Conventional processing techniques for advanced materials, special processing techniques, use of computers in metal processing.
7	CHARACTERIZATION AND EVALUATION TECHNIQUES:Destructive and Non-destructive evaluation techniques, Electron and X-ray techniques, Distortion and Residual stress measurement.
8	PERFORMANCE OF MATERIALS IN SERVICE:Service performance, corrosion and its control, Delayed fracture, Performance of materials at High & low temperatures, Radiation damage and recovery

## REFERENCE BOOKS:

1. Material Science for engineers by James F Shackelford & Madanapalli K. Muralidharan, Pearson Education.
2. Elements of Material Science – Sixth edition by Laurence H. Van Vlack, Pearson Education.
3. Engineering Design- A Material and Processing Approach / George E. Deiter, McGraw Hill Intl., 2nd Edition, 2000.
4. Theory of Elasticity and Plasticity by Timoshenko.
5. Engineering Materials & Their Applications. – R. A. Flinn & P. K. Trojan.
6. Materials & Process In Manufacturing. – E. Paul Degarmo & J. I. Black.
7. Material – Selection & Design. – ASM Handbook Vol.-20.
8. Materials – Principles & Practice. – Charles Newey & Graham Weaver.
9. Material Science & Engineering. – Callister W. D.



# GUJARAT TECHNOLOGICAL UNIVERSITY

M.E Semester: 1

## Mechanical Engineering (CAD/CAM)

Subject Name Mechanical Engineering For Mechatronics

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Sr.No	Course content
1.	Introduction to Mechatronics: Origin and evaluation, definition, multidisciplinary scenario, need in industry, objectives, design of Mechatronics systems, modules in the system, Mechatronics technology, Mechatronics and engineering skills, overview, system and Mechatronics, measurement system, microprocessor based controllers, engine management system, automatic camera, automatic washing machine and automatic bathroom scale.
2.	Overview of Sensors and Transducers: Definitions, classification, performance parameters, pressure sensors and flow sensors, Hall effect sensors, light sensors, proximity sensors, optical sensor and desirable features of sensors and transducers.
3	Hydraulic System: Actuators, Hydraulic Cylinders and their types, Hydraulic Motors and their types, Valves and their types, symbols for Hydraulic System Components, general hydraulic circuit, different types of hydraulic circuits and hydrostatic transmission.
5	Pneumatic Systems: Introduction to pneumatics, gas laws, compressed air generation and contamination control, pneumatic actuators, valves and control circuits, multiple-actuators circuits, pneumatic applications, maintenance, trouble shooting and safety.
6	System Models: Elements of mechanical systems, spring mass damper system, an unconventional Approach, arrangement and application of mechanical elements, elements of Electrical Engineering, unconventional solution to RLC circuit, application of DC Servomotor, Hydraulic System Modelling, Modelling of actuators and control valves and Thermal Systems and their Modelling.
7	Elements of Machine Tools: Structure, design considerations for structures, guide ways, their requirements and classification, slide ways, stick-slip phenomena, antifriction ways, shapes and types slide ways, re-circulation ball screw and nut, planetary roller screw, spindle and spindle bearings, types of loads on spindles, types of bearings, bearing material selection, antifriction bearings, preloading and its methods for re-circulating ball screw and antifriction bearing and frictionless bearings

## **LIST OF PRACTICALS:**

Sr. No.	Practicals
1.	Introduction to Mechatronics.
2.	Knowledge of mechanical engineering required for Mechatronics.
3.	Overview of sensors and transducers.
4.	Hydraulic system and its components.
5.	Prepare hydraulic circuit for given application.
6.	Pneumatic system and its components.
7.	Prepare pneumatic circuit for given application.
8.	Preparation of system models.
9.	Machine Tools and their components.
10.	Design of machine tool component.

## **Reference Books:**

- (1) Mechatronics- Ganesh S. Hegde, Published by University Science Press (An imprint of Laxmi Publication Private Limited ).
- (2) Mechatronics by H.M.T., Ltd., Tata McGraw Hill Publication Co. Ltd.
- (3) Pneumatic Controls- Joji P, Wiley India Private Limited.

# GUJARAT TECHNOLOGICAL UNIVERSITY

M.E Semester: 1

**Mechanical Engineering (CAD/CAM)**

Subject Name CAD & Solid modelling Lab

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Sr. No.	Practicals
1.	To prepare a computer program for scan converting a line using Bresenham's algorithm.
2.	To prepare a computer program for scan converting a circle using Bresenham's algorithm.
3.	Preparation of computer program for 2D transformations.
4.	Preparation of computer program for 3D transformations.
5.	Study of DXF, IGES, STL and script file formats and preparing models.
6.	Study of Solid Modelling and making models using commercial software.
7.	Study of Wire frame Modelling and making models using commercial software.
8.	Study of Surface Modelling and making models using commercial software.
9.	Computer program preparation for the designing of Machine components using File / Database management.
10.	Development of computer program for the Optimization of Machine elements.

Software Practice Project- Acquire skill to use any CAD software, to prepare solid models of assembly and components and prepare the views from CAD file of solid models. A project to prepare solid models and their views of assembly and components is to be completed and submitted.

# GUJARAT TECHNOLOGICAL UNIVERSITY

M.E Semester: 1

**Mechanical Engineering (CAD/CAM)**

Subject Name CAPM & Programming Lab

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Sr. No.	Practicals
1.	Salient features and facilities of ideal software.
2.	'C', 'C++' programming.
3.	Forecasting methods and c program of any one.
4.	Computerized plant layout design.
5.	Material requirement planning.
6.	Group technology.
7.	Computer aided process planning.
8.	Algorithm and 'C' program for sequencing / scheduling.
9.	Computer aided quality control.
10.	Shop floor control & computer process monitoring.
11.	Enterprise resource planning.
12.	Simulation.

Programs are to be developed and used in above topics. At least one project and case study should be undertaken. Recent research and development are to be referred.

# GUJARAT TECHNOLOGICAL UNIVERSITY

M.E Semester: 2

**Mechanical Engineering (CAD/CAM)**

Subject Name Finite Element Method

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Sr.No	Course content
1.	Introduction to FEM: basic concepts, historical back ground, application of FEM, general description, comparison of FEM with other methods, Variational approach, Galerkin's Methods.
2.	Co-ordinates, basic element shapes, interpolation function. Virtual energy principle, Rayleigh- Ritz method, properties of stiffness matrix, treatment of boundary conditions, solution of system of equations, shape functions and characteristics, Basic equations of elasticity, strain displacement relations
3.	1-D structural problems – axial bar element – stiffness matrix, load vector, temperature effects, Quadratic shape function. Analysis of Trusses – Plane Truss and Space Truss elements
4	Analysis of beams – Hermite shape functions – stiffness matrix – Load vector – Problems 2-D problems –CST, LST, force terms, Stiffness matrix and load vector, boundary conditions.
5	Isoparametric element – quadrilateral element, Shape functions – Numerical Integration – sub parametric and super parametric elements. 3-D problems – Tetrahedral element – Jacobian matrix – Stiffness matrix.
6	Dynamic considerations, Dynamic equations – consistent mass matrix – Eigen Values, Eigen Vector, natural frequencies – mode shapes – modal analysis
7	Applications of numerical procedures to determine natural frequencies and mode shapes. Finite Element Method for dynamic analysis
8	Scalar field problems - 1-D Heat conduction – 1-D fin element – 2-D heat conduction problems – Introduction to Torsional problems
9	Introduction to Non linearity, Non linear problems; Geometric Non-linearity, Material Non-linearity, Non linear dynamic problems, analytical problems

## **Tutorials:**

Tutorials should be given based on the below mentioned topics :

1. 1D & 2D structural analysis.
2. 1D and 2D heat transfer problems.
3. Analysis of plane trusses.
4. Computation of shape function.
5. Computer programmes for 3D structural analysis.
6. Formulation and solution of dynamic problems using computer programmes.

## REFERENCE BOOKS:-

1. Introduction to finite elements in engineering by Tirupathi K. Chandrupatla and Ashok D.Belegundu.
2. CAD / Cam and Automation by Farazdak Haidery, Nirali Prakashan.
3. Practical Finite Element Analysis by Nitin S. Gokhale, Sanjay S.Deshpande, Sanjeev V. Bedekar and Anand N. Thite, Finite to infinite, Pune.
4. Finite Element Procedures in Engineering analysis by K.J Bathe.
5. An Introduction to Nonlinear Finite Element Analysis by J.N.Reddy, Oxford University Press.
6. The finite element methods in Engineering – S.S. Rao - Pergamon, New York.
7. An Introduction to Finite Element Methods – J. N. Reddy – Mc Graw Hill.
8. A Textbook of Finite Element Analysis by P. Seshu
9. The Finite Element Method in Engineering science – O.C. Zienkiewicz, Mc Graw Hill. Concepts and applications of finite element analysis – Robert Cook

# GUJARAT TECHNOLOGICAL UNIVERSITY

M.E Semester: 2

**Mechanical Engineering (CAD/CAM)**

Subject Name Computer Aided Manufacturing

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Sr.No	Course content
1.	<p>NC / CNC MACHINES: Numerical Controls, types, evolution of controllers, Programmable Logic Controllers, components of NC/CNC system, specification of CNC system. Classification of NC /CNC machines, transducers used, salient features, Tape, Tape codes and tape readers used in NC machines constructional details of CNC machines, axis designation, NC/CNC tooling -Fundamentals of manual part programming , types of format, word address format manual part programming for drilling, lathe and milling machine operations, subroutines, do loops, canned cycles, parametric sub routines, Macros.</p> <p>-Computer assisted part programming: - Need, list of computer assisted programming languages, Automated Programmed Tools language- its types of statement, command and programming-CAD based CNC programming using CAM software.</p>
2.	<p>FLEXIBLE MANUFACTURING SYSTEM:</p> <p>-FMS definition and description need of FMS</p> <p>-General FMS Considerations, objective, management commitment and planning, types of FMS, main elements of FMS, flexibilities, their measurements , various mathematical techniques for flexibility measurements.</p> <p>-Manufacturing cells , cellular v/s flexible manufacturing</p> <p>-Systems planning, physical planning –human resources, Concepts of Quality, JIT and GT as applied to FMS</p> <p>-Processing and Quality assurance equipments- Turning centre, Machining centre, Cleaning and debarring equipment, co ordinate measuring machines- their types-working , capabilities etc.</p> <p>-System support equipment-Automated material movement and Automated Storage and Retrieval Systems (ASRS), scheduling of AGVs, cutting tools and tool management, work holding considerations</p> <p>-FMS computer hardware &amp; software-general structure and requirements.</p> <p>-FMS installation and implementation –acceptance testing, maintenance concern</p>
3.	COMPUTER INTEGRATED MANUFACTURING SYSTEMS:

	<p>-Introduction to CIMS, nature, types of manufacturing system, evaluation, CIMS hardware and software, benefits, scope and needs, CIMS wheel, elements of CIMS and their role, computer technology and manufacturing, database requirement, fundamentals of communication, data base management, database models, DBMS architecture, SQL -Steps to implement CIM, its management, personnel, emerging technologies like expert systems, computer vision, lasers in manufacturing (machinery and metrology), laser meets CNC, concurrent engineering, multimedia communications, best people practices.</p> <p>-CIM specification, application, development of experiments and facilities needed, economics, justification, case studies.</p> <p>-Expert systems and AI based scheduling in CIM environment.</p> <p>-CAD/CAM Integration: - Activities involved, case studies, software requirements, hardware requirements, factory automation, implementation issues economic justification</p>
4	MECHATRONICS : Digital Logic and Logic Families, Micro-controllers and Programming, Parallel I/O and Interrupt Mechanism, Sensors and their Interface.

#### REFERENCE BOOKS:-

1. Numerical control and computer aided manufacturing – T.K. Kundra, P.N.Rao and N.K.Tewari – Tata McGraw Hill Publishing company Ltd.
2. CNC Programming by Yorem Koran.
3. Computer numerical control machines –P.Radhakrishnan ,New Central Book Agency
4. CNC programming – Dr. S.K.Sinha – Galgotia publications.
5. Flexible Manufacturing Cells and System -William. W. Luggen Prentice Hall, England Cliffs, NJ.
6. CAD, CAM and CIM – P. Radhakrishan, S. Subramaniam , New Age International.
7. Mechatronics- Integrated Technologies for Intelligent Machines  
A. Smaili and F. Mrad - Publisher-Oxford University Press



# GUJARAT TECHNOLOGICAL UNIVERSITY

M.E Semester: 2

**Mechanical Engineering (CAD/CAM)**

Subject Name Robotic Engineering

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Sr.No	Course content
1.	INTRODUCTION: Automation and Robotics, Robot anatomy, robot configuration, motions joint notation work volume, robot drive system, control system and dynamic performance, precision of movement.
2	CONTROL SYSTEM AND COMPONENTS: basic concept and modals controllers control system analysis, robot activation and feedback components. Positions sensors, velocity sensors, actuators sensors, power transmission system..
3	MOTION ANALYSIS AND CONTROL: Manipulator kinematics, position representation forward transformation, homogeneous transformation, manipulator path control, robot dynamics, configuration of robot controller.
4	END EFFECTORS: Grippers-types, operation, mechanism, force analysis, tools as end effectors consideration in gripper selection and design..
5	SENSORS: Desirable features, tactile, proximity and range sensors, uses sensors in robotics
6	MACHINE VISION: Functions, Sensing and Digitizing-imaging, Devices, Lighting techniques, Analog to digital single conversion, Image storage, Image processing and Analysis-image data reduction, Segmentation feature extraction. Object recognition, training the vision system, Robotics application.
7	ROBOT PROGRAMMING:Lead through programming, Robot programming as a path in space, Motion interpolation, WAIT, SIGNAL AND DELAY commands, Branching capabilities and Limitations
8	ROBOT LANGUAGES: Textual robot languages, Generation, Robot language structures, Elements in function
9	ROBOT CELL DESIGN AND CONTROL: Robot cell layouts-Robot centered cell, In-line robot cell, Considerations in work design, Work and control, Inter locks, Error detection, Work cell controller.
10	ROBOT APPLICATION: Material transfer, Machine loading/unloading. Processing operation, Assembly and Inspection, Feature Application.
11	RECENT TRENDS IN ROBOTICS: Multi-axis robots, intelligent robots.

## **Reference Books:**

1. Introduction to Robotics Analysis, Systems, Applications by Saeed B Niku PHI.
2. A Robot Engg text book by Moshen Shahinpoor, Harper and Row Publishers, NY.
3. Fundamentals of Robotics – Analysis and Control, Robert J Schilling, PHI.
4. Robotic technology, Principles and practice – Werner G Holz book – Van Nostrand Reinhold Co NY.
5. Robotic Engineering – An Integrated Approach by Richard D Klaffer, Thomas A Chmielewski, Michael Negin – PHI.
6. Robot Dynamics and Control – Mark W Spong, M Vidyasagar – Wiley India.
7. Intro to Robotics, Mechanics and Control by John J Craig, Pearson Education.
8. Modelling and Control of Vehicular and robotic systems by Sisil Kumararawadu – Narosa publishing house.
9. Industrial Robots by Ganesh S Hegde – Laxmi Publications.

# GUJARAT TECHNOLOGICAL UNIVERSITY

M.E Semester: 2

**Mechanical Engineering (CAD/CAM)**

Subject Name Experimental Modal Analysis and Dynamic Design

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Sr.No	Course content
1.	Dynamic test data measurement and processing methods, signature analysis. Frequency response functions for multi-degree-of-freedom systems, free and forced response of structures. Introduction to Modal testing. Orthogonality principle
2.	Modal Analysis techniques: For SDOF systems, Circle fit method – Modal circle, Inverse or line fit method, Calculation of Residual mass and stiffness. Multi degree of freedom methods Non-linear least squares, Rational Fraction Polynomial Method (RFP).
3.	Experimental and theoretical modal analysis algorithms and codes. Applications of modal testing in system and force identification, structural dynamic modification, sensitivity analysis and frequency response coupling of substructure etc
4	Dynamic design of mechanical equipment structures via model testing, Application of Model testing, Modal Assurance Criterion (MAC), structural dynamic modification and model updating techniques like Direct matrix updating, Error matrix method, Inverse Eigen Sensitivity Method (IESM), Response Function Method (RFM). Analysis of beams, 'F' structures for modal analysis
5	Introduction to Non-linear vibration analysis. Introduction to discrete systems and finite element modelling. Comparison of numerical data with test results. Introduction to model updating, Techniques of correlation of analytical and experimental models.

## **Reference Books:**

1. Modal Testing : Theory, Practice and applications by D. J. Ewins, Research Studies Press, U.K.
2. Mechanical Vibrations by Singiresu S. Rao, Pearson Education.
3. Vibration Modal Analysis and parameter identification by Fu Z, Mechanical Industry Publishing Co, China.
4. Vibration Testing Theory & Practice by McConnell K G, John Wiley and Sons.
5. Handbook on Modal Testing, Dynamic Testing Agency.
6. Experimental Methods for Engineers, J. P. Holman, Mc Graw Hill, New York.
7. Vibration Analysis by R. A. Vierck, Harper & Row, New York.

# GUJARAT TECHNOLOGICAL UNIVERSITY

M.E Semester: 2

**Mechanical Engineering (CAD/CAM)**

Subject Name Machine Tool Design

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Sr.No	Course content
1.	Design requirements of machine tools. A design approach for machine tools. Identification and quantification of objectives and constraints in machine tool design.
2.	Estimation of power requirements and selection of motor for metal cutting machine tool spindles.
3.	Design of gearbox, spindle and guide ways.
4	Principles of design of structural components, namely, head stock, tail stock, carriage, table, knee, column and over arms to achieve desired static & fatigue strength, stiffness, dynamic characteristics and other requirements.
5	Exercises on the design of machine tools using existing CAD software packages.
6	Design aspects of Modern CNC machine tools. CNC structures, Design/selection of linear motion systems, ball screws, CNC feedback devices, CNC spindles, bearings, feed drives and servomotors for CNC machine tools.

## REFERENCE BOOKS:

1. Handbook of Machine Tools by Malfred Weck, John-Wiley publication Vol. 1 to 4.
2. CMTI Handbook of Machine tool design.
3. Principle of Machine Tool Design by N.K.Mehta.
4. Principle of Machine Tool Design by S.K.Basu.

# GUJARAT TECHNOLOGICAL UNIVERSITY

M.E Semester: 2

**Mechanical Engineering (CAD/CAM)**

Subject Name Vibration Engineering

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Sr.No	Course content
1.	Introduction to unwanted mechanical vibrations and their harmful effects including those on human beings.
2.	Experimental and theoretical routes to vibration engineering. Vibration Testing. Spatial, Modal and Response models of vibrating systems. Lumped parameter and distributed parameter modeling of mechanical vibratory systems.
3.	Free vibrations and Forced response solutions of Single and multi degree of freedom models including modeling of damping.
4	Distributed parameter models of rods, bars and beams.
5	Vibration control solutions: Balancing of rotating and reciprocating machines. Design of vibration isolators. Auxiliary mass systems including tuned dampers for vibration control.
6	Application of damping treatment for vibration control in machines and structures. Dynamic instability control.
7	Design of Accelerometers, Velometers.
8	Introduction to Modal Analysis, model updating and structural dynamic modification to improve dynamic design of machine structures. Active control of vibrations. Introduction to Noise Vibration Harshness and its control.
9	Vibration control strategies and case studies.

## REFERENCE BOOKS:

1. Mechanical Vibrations by Singiresu S. Rao, Pearson Education.
2. Mechanical Vibrations by Kshitij Gupta & J.S. Rao.
3. Mechanical Vibrations by W. Thomson

# GUJARAT TECHNOLOGICAL UNIVERSITY

M.E Semester: 2

**Mechanical Engineering (CAD/CAM)**

Subject Name Automation in Production and Hydraulic Control

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Sr.No	Course content
1.	AUTOMATION IN PRODUCTION
2.	Basics of automated work piece handling, preparation for automated handling, working principles and techniques, solution for feeding arrangements, vibratory feeder, transfer mechanisms, automated feed out of components.
3.	Construction elements for automation, concepts of transfer lines, unit built machines, Special Purpose Machines, Machining centers.
4	Assembly automation, automated packaging, automated inspection, use of pneumatic, hydraulic systems for automation.
5	HYDRAULIC CONTROL IN MACHINE TOOLS.
6	Hydraulic Principles- Elements of hydraulic system ( Pumps, Filters, Seals, Valves, accumulators etc) Study of their functional and design characteristics.
7	Analysis and study of typical hydraulic circuits in M/C tools.
8	Design of systems for specific requirements, introduction to servo systems.
9	Maintenance of Hydraulic systems, Pneumatic & Hydro pneumatic circuits

## REFERENCE BOOKS:-

1. Automation, Production System and Computer Aided Mfg – M.P. Groover.
2. Automatic assembly and product design – Geoffry Boothroyd.
3. Handbook of low cost automation techniques by H.A. Thomas.
4. Machine tool design – CMTI – Tata Mcgrowhill publication.
5. Hydraulic control of machine tools – EM Khaimoswitch – Pergamon press.
6. Machine tool design by N.K.Mehta.
7. Machine tool design–Acharkahn vol. II Vickers Sperry catalogue

# GUJARAT TECHNOLOGICAL UNIVERSITY

M.E Semester: 2

**Mechanical Engineering (CAD/CAM)**

Subject Name Manufacturing Processes and Analysis

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Sr.No	Course content
1.	<b>FORMING:</b> Fundamental theories of plasticity and mechanics of plastic deformation. Stress-strain relationships, deformation equations, methods for solution of problems in metal forming such as slab analysis, upper bound analysis etc., deformation zone, geometry, Hydrostatic pressure, workability, residual stresses, classification of metal forming processes and analysis of any one forming process. Design of Press Tools.
2.	<b>CASTING:</b> Basic concepts of engineering analysis of casting, factors influencing the production of engineering casting to customer's specifications, Design for casting, functional design, dimensional features, metallurgical factors, strength/weight considerations, sources of fluctuation in properties, influence of form and environment, permanent mould casting, centrifugal casting, continuous casting, vacuum casting, flaskless moulding, shell, investment, polystyrene (full mould casting), Co <sub>2</sub> moulding and analysis of any one of the above processes.
3	<b>WELDING:</b> General concepts of weld design, analysis of stresses in welded structures, permissible stresses, standards, calculation of the size of welds for static and dynamic loading, location and orientation of welds in an assembly, residual stresses, distortion and their control, weldability.
4	<b>MACHINING:</b> Hot machining, deep hole drilling, metal spinning, cryogenic machining, micro-Machining.
5	<b>NON CONVENTIONAL MACHINING:</b> Mechanism, transfer medium, immediate source of energy and application of all non conventional processes, identification of variables and analysis of EDM chemical machining, Laser machining, AJM and USM.
6	<b>RAPID PROTOTYPING AND TOOLING:</b> Geometrical modeling, Reverse engineering, Virtual / Augmented reality, DFX, RP Methods, Stereo lithography, Fused-deposition modeling, Selective laser sintering, Laminated-object manufacturing, Ballistic particle Manufacturing, Solid-base curing and Direct manufacturing and rapid tooling

**REFERENCE BOOKS:-**

1. Mechanical metallurgy- George E Dieter – McGraw Hill.
2. Principles of industrial metal working process – Rowe G. W.
3. Principles of metal casting- Heine & Rosenthal.
4. Welding and its application- Rossi B. E.
5. Modern machining processes- P. C. Pandey, H. S. Shan.
6. Rapid Product Development- Synergic integration of time-compression technologies by K. P. Karunakaran, V. P. Bapat, Sreenath Babu Akula, P. D. Solanki, Gaurav Gupta, V.R. Prasanth, Saket Anand, Arnab Sarkar and S. Venkatkrishnan.
7. Manufacturing Processes for Engineering Materials by Serope Kalpakjian and Steven R. Schmid- Pearson Education.



# GUJARAT TECHNOLOGICAL UNIVERSITY

M.E Semester: 2

**Mechanical Engineering (CAD/CAM)**

Subject Name Product Design & Development

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Sr.No	Course content
1.	Importance of product design, type of design product definition, product specification, Phases of product development: conceptual, embodiment and detailed design, product and technology development cycle, concept generation and evaluation methods.
2.	Material selection– Importance, classification material performance characteristic, selection criteria Ashby Material selection chart.
3.	Process selection – Importance types of manufacturing process and their classification Sources of information selection criteria Material and Process selection Methods, Expert systems. Computer Database Approach, performance indices decision matrix, AHP and fuzzy approach introduction to material and process selection software.
4.	Benchmarking – DFM, DFA, DFX, supplier involvement robust design, QFD and concurrent engineering.
5.	Mathematics of Times Value of Money Cost Comparison Depreciation Taxes. Inflation profitability of Investment and Investment Decision Analysis Sensitivity Analysis. Methods of cost Estimates Industrial Engineering Approach parametric Approach, Introduction to Assembly Modeling. Top-Down and Bottom-Up Approaches of AM. Mating Conditions Representation Schemes. Generation of Assembly Sequences.
6.	Product Development Cycle and Importance of Prototyping. Types of prototypes. Principal and advantages & Different Type of Generative Manufacturing process, Viz. Stereo lithography. FDM, SLS etc. Factors Concerning to RP: Consideration for Adoptions, Advantages, Accuracy and Economic Consideration.

## REFERENCE BOOKS:

- 1 Product Design and Manufacturing by A.K.Chitale, R.C.Gupta, PHI.
- 2 Product Design and Development by Ulirich Karl T. and Eppinger Steven D, McGraw Hill.
- 3 Engineering Design by Dieter George E., McGraw Hill.  
Handbook of Product Design for Manufacturing by Bralla, James G, McGraw Hill.

# GUJARAT TECHNOLOGICAL UNIVERSITY

M.E Semester: 2

**Mechanical Engineering (CAD/CAM)**

Subject Name Modern Machining Methods

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Sr.No	Course content
1.	INTRODUCTION: Unconventional Machining Process, Need – clarification – Brief overview of all techniques.
2.	MECHANICAL ENERGY BASED PROCESSES: Abrasive Water Jet Machining, Water Jet Machining, Ultrasonic Machining (AJM / WJM/ USM). Working principles – equipments used – process parameters – MRR – Variation in techniques used – Applications.
3	ELECTRICAL ENERGY BASED PROCESSES: Electro Discharge Machining, Working principles – Equipments – Process parameters – MRR – electrodes/ tools / power circuits – tool wear – Dielectric- flushing- Wire cut EDM – Applications.
4	CHEMICAL AND ELECTRO-CHEMICAL ENERGY BASED PROCESSES: Chemical Machining, Electro- Chemical Machining – Etchants- maskant- Techniques of applying maskants – Process parameters – MRR – Applications. Principles of ECM-MRR-Electrical circuit – process parameters – ECG and ECH applications.
5	THERMAL ENERGY BASED PROCESSES: Laser Beam Machining, Plasma Arc Machining and Electron Beam Machining. Principles – equipments – types – beam control techniques- applications.

Sr.No	Practicals
1.	Introduction to unconventional machining.
2.	Influence of parameters in Abrasive Jet Machining.
3.	Influence of parameters in Ultrasonic Machining.
4.	Influence of parameters in Electro-Discharge Machining.
5.	Influence of parameters in Wire-cut EDM.
6.	Study of Chemical and Electro-chemical Machining.
7.	Study of Laser Beam Machining.
8.	Study of Plasma Arc Machining.
9.	Study of Electron Beam Machining.
10.	Study of Hot Machining.

#### **REFERENCE BOOKS:-**

1. Modern Machining Processes by P.C.Pandey & H.S. Shan, Tata McGraw Hill.
2. Manufacturing Science by Amitabha Ghosh.
3. Advanced Machining Processes by Vijay K.Jain, Allied Publishers.
4. Non traditional Manufacturing Processes by G.F. Benedict, Marcel Dekker Inc., NY.
5. Advanced Methods of Machining by McGeough, Chapman and Hall, London.
6. New Technology by A. Bhattacharya, Institute of Engineers, India.
7. Material & Processes in Manufacturing by Paul De Garmo, J.T. Black and Ronald A. Kohser, PHI.

# GUJARAT TECHNOLOGICAL UNIVERSITY

M.E Semester: 2

**Mechanical Engineering (CAD/CAM)**

Subject Name FEM & Software Lab

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Sr. No.	Practicals
1.	Study of Finite Element Analysis and its different approaches.
2.	Basic procedure of Finite Element Method and Mathematical formulation of problems.
3.	Analysis of 1D structural members and verification of the same through manual calculation.
4.	Beam analysis problems and their verification.
5.	Analysis of 1D and 2D trusses, their formulation and use of software.
6.	Preparation of 3D model of a part and its analysis.
7.	Formulation of Dynamic problem and its solution for finding Eigen values and Eigen vectors.
8.	Problem formulation of 1D & 2D heat transfer problem and verifying solution using software.
9.	Study of Numerical procedures for the dynamic analysis of simple structures.

Programs are to be developed and used in above topics.

At least one project and a case study should be carried out based on recent publications / research papers / technical development.

# GUJARAT TECHNOLOGICAL UNIVERSITY

M.E Semester: 2

**Mechanical Engineering (CAD/CAM)**

Subject Name CAM & Software Lab

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Sr. No.	Practicals
1.	Introduction and features of advanced CNC system.
2.	Construction and working.
3.	Manual part programming preliminaries.
4.	Manual part programming Exercises.
5.	Computer Assisted Programming –APT and exercises.
6.	CAM Software and an exercise
7.	Introduction, Flexibilities, Computer Hardware, Software and functions.
8.	Scheduling Techniques and use of GT & JIT.
9.	Introduction, Steps to implement CIMS, Expert systems AI based scheduling.
10.	Specifications and features.
11.	CAD/CAM Integration and case study.
12.	Study of micro processors and micro controllers.
13.	Exercise on micro controller programming.