Sardar Patel University, Balaghat (M.P.)

Curriculum

For

Diploma

Mechanical Engineering

From Session: 2024-25

SARDAR PATEL UNIVERSITY, BALAGHAT (MP)

School of Engineering and Technology

Syllabus

Subject: Fluid Mechanics & Hydraulic Machines, Subject Code: DME-041

Course: Diploma, Branch: Mechanical, Semester: IV

Academic Session: 2024-25

Course Contents

Course Objectives:

1. Recognize the type of fluid flow occurring in a particular physical system.
2. Apply appropriate simplifying assumptions and basic fluid-flow principles to produce a mathematical model of a physical fluid-flow system.
3. Recognize the flow regime that is present in a typical engineering system.
4. Recognize the type of loss occurring in a pipe system and be able to use the values in energy calculation.
5. Compute the magnitude of different forces acting in a flow system using CFD tool

UNIT I

Fundamentals of Fluid Flow: Definition of fluid, Types of fluids, fluid properties, Types of flow, Continuity equation,

Pressure and Its Measurement: Concept of pressure, intensity of pressure, Pascal's law, pressure head, gauge pressure, vacuum pressure, absolute pressure, manometers- Pressure gauges, Bourdon tube pressure gauge. Simple numerical problems on differential manometers.

Basic Equation of Fluid Flow: Various form of energies applicable to fluid flow, Concept of datum pressure, velocity and total head of a fluid particle in motion. General steady flow energy equation, Bernoulli's theorem, practical applications of Bernaulli's equation. Simple problems on venturi meter, orifice meter, pitot tube.

UNIT II

Flow Through Orifices and Mouth Pieces and flow measurement: Definition and types of orifices, Vena contracta, coefficient of contraction, velocity, discharge and resistance. Torricelli's theorem experimental determination of Cc, Cv and Cd. Mouth pieces. Flow measurement by Rota meter, Volume flow meter.

Flow Through Notches and Weirs: Weirs and notches definition, Classification, flow over rectangular weir with and without velocity of approach, calibration of rectangular weir, different formula for large rectangular weir. Time required to empty a reservoir with rectangular weir, V-notch. Trapezoidal notch.

UNIT III

Flow Through Pipes: Laminar and turbulent flow, Raynold's number, differentiation of laminar and turbulent flow on the basis of Reynold's number, loss of head due to friction in pipes, Darcy's formula and Chazy's equation. Hydraulic gradient and total energy line. Flow through

long pipes, pipes in series and parallel simple problems based on above formulae water hammer and its effect surge tank.

UNIT IV

Impact of Jets: Impact of Jet on flat and curved plates stationary and moving, work done by Pelton wheel, velocity triangle, simple numerical problems on axial, radial flow.

Water Turbines: Meaning Classification Impulse and reaction turbine, Comparison description and working of Pelton, Francis and Kaplan turbines,

Water Pumps: Centrifugal and reciprocating- principle construction, working classification and layout. Comparison of centrifugal and reciprocating pumps. Specific speed, selection of pumps. Use of air vessels in reciprocating pump, indicator diagram, horsepower calculation in case of reciprocating pump. Horsepower calculation in case of centrifugal pump. Operating characteristics.

UNIT V

Model Analysis: Geometric, Kinetic and dynamic similarity. Simple Problems.

Hydel Power Station: Schematic diagram, function of various elements, advantage over other power stations.

LIST OF EXPERIMENTS:

1. To measure the pressure of water in pipe by
    a. Piezometer
    b. different types of monometers
2. To verify Bernaulli's equation.
3. To determine discharge through a given venturi meter.
4. To determine discharge through a given orifice meter.
5. To determine discharge through a Pitot tube.
6. To determine Cc, Cv and Cd for different types of orifices and mouth pieces.
7. To determine loss of head due to:
    a. Sudden enlargement.
    b. Friction in pipes.
8. Study of Pelton wheel, Francis turbine, and Kaplan turbines.
9. To determine performance characteristics.
10. Study of reciprocating pump.
11. To determine H.P. of reciprocating pump.
12. To determine discharge through different types of notches.
13. Study of centrifugal pump.

Reference Books:

- A textbook of Hydraulics, Fluid Mechanics and Hydraulic Machines. by Khurmi (S. Chand & Co.)
- Fluid Machines by M. Manohar
- Hydraulics & Hydraulic Machines by Dr. Jagdish lal (Metropolitan)
- Hydraulics & Hydraulic Machines by Priyani.
- Fluid Machines with Engineering Applications by R.L. Draught lery & A.C. Jubers'll. (McGraw Hills)
- Journal of experiments in Hydraulic Laboratory by V. N. Rao & Hussan New Heights.
- Fluid Mechanics by Dr. M.L. Mathur (Std. Publications).
- Taral Yantriki Avum Machinery (Hindi) by G.B. Bamanker. (Deepak Prakashan, Gwalior).

Course Outcomes:

1. Understand fluid properties, types of flow, and apply Bernoulli's theorem in fluid flow analysis.
2. Apply pressure measurement techniques using Pascal's law and manometers for practical problems.
3. Analyze flow through orifices, notches, and use flow measurement devices like rotameters and weirs.
4. Differentiate laminar and turbulent flow in pipes, and calculate head losses using Darcy's and Chazy's equations.
5. Evaluate the impact of jets on plates and turbines, and compare Pelton, Francis, and Kaplan turbines.

SARDAR PATEL UNIVERSITY, BALAGHAT (MP)

School of Engineering and Technology

Syllabus

Subject: Thermal Engineering-II, Subject Code: DME-042

Course: Diploma, Branch: Mechanical, Semester: IV

Academic Session: 2024-25

Course Contents

Course Objectives:

1. Demonstrate the supercritical steam generator system and able resolve the problem related with efficiency and Heat balance sheet of the steam generator
2. Understand the basic ideas of steam power plant and to solve the steam power plant complex problems.
3. Analyze basic concept of gas dynamic problem, able to identify the various parameter of gas dynamic that involves in the topic and to setup mathematical model by utilizing the engineering knowledge.
4. Describe of engineering basic of Rotary & axial flow air compressor.

UNIT I

Thermodynamic Cycles: Air Standard cycles- definition and purpose standard efficiency, Carnot, Otto Diesel dual and Brayton cycles, their representation on P-V & T-S Diagrams. Derivation of air Standard efficiency and their comparison and limitation of each cycle. Vapour power cycle - Carnot cycle its limitation, Rankine cycle modified Rankine cycle- their representation on P-V, T-S. and H-S. Planes, derivation of expression for thermal efficiency.

UNIT II

Steam Generators: Definition, classification, working of Babcock and Wilcox Boiler and Lancashire, Boiler Mountings and accessories.

Steam Nozzle, Condensers and Turbines: Steam nozzle and its use, Condenser-Classification, construction and working of surface condenser, Classification, working principle of steam turbines, difference between impulse and reaction turbine, compounding of steam turbine, velocity diagram (introductory and its use) Governing of steam turbine.

UNIT III

Two Phase System: Pure substance phase, phase changes steam as a two-phase system steam formation and its representation on temp- enthalpy plane. Properties changes, representation of wet dry and saturated and superheated steam on P.V., T.S. and H.S. planes. Dryness fraction of steam, methods of determination of dryness fraction separation and throttling calorimeter. Use of steam tables and Mollier's diagram. Determination of change in properties such as entropy enthalpy internal energy and work and heat transfer in the following processes- isobaric, isochoric, isothermal, isentropic, polytropic, throttling, and representation of various processes on P.V. and H.S. planes.

UNIT IV

Internal Combustion Engines: Introduction, classification I.C. Engine Components and their function, working of two stroke and four- stroke cycle engines and their comparison. Indicator diagram, Calculation of IHP, BHP thermal efficiency, Mechanical efficiency and relative efficiency, Governing, Cooling and lubrication of I.C. Engines.

UNIT V

Heat Transfer: Modes of heat transfer; Conduction convection and Radiation. Fourier's law of heat conduction, temperature gradient, expression for determination of heat transfer across a flat plate, thermal conductivity and thermal resistance. Newton's law for heat transfer by convection, free and forced convection. Heat transfer by radiation Stefan-Boltzmann Law of thermal radiation.

List of Experiment:

1. To determine valve/port timing diagram of a Petrol/Diesel engine.
2. To conduct performance test on single cylinder Diesel engine.
3. To conduct heat balance test on a Diesel engine.
4. To conduct Morse test on multi cylinder Petrol engine.
5. To conduct performance test on multi cylinder Petrol engine.
6. To conduct performance test on two-stroke Petrol engine.
7. To conduct performance test on multi cylinder Diesel engine.
8. To study the performance of a Petrol engine under different compression ratios
9. Exhaust gas analysis of Diesel engine for carbon deposits using smoke meter.
10. Determination of flash and fire points of a Fuel
11. Study of boilers by using models
12. Study of boilers mountings & accessories

Reference Books:

- Engineering Thermodynamics by P. K. Nag, Tata McGraw Hill ltd.
- Engineering Thermodynamics, C. P. Gupta, Rajendra Prakash
- Thermal Engineering by P.L. Ballani. (Khanna Publisher's Delhi)
- A Course in thermodynamics And Heat Engines by Kothanandran, Khajuria and Arora (Dhanpat Rai & Sons Delhi)
- Thermodynamics by G.T. Van Wylen (john Wiley &Sons)

Course Outcomes:

1. Understand and compare air standard cycles and vapor power cycles, including their efficiencies and limitations.
2. Explain the working principles of steam generators, nozzles, condensers, and steam turbines, and analyze their performance.
3. Analyze phase changes in steam systems, use steam tables and Mollier diagrams, and determine changes in thermodynamic properties.
4. Comprehend the classification, components, and working principles of internal combustion engines, and calculate performance parameters.

SARDAR PATEL UNIVERSITY, BALAGHAT (MP)

School of Engineering and Technology

Syllabus

Subject: Kinematics Of Machines, Subject Code: DME-043

Course: Diploma, Branch: Mechanical, Semester: IV

Academic Session: 2024-25

Course Content

Course Objectives:

1. Analyze and understand the dynamics i. e. position, velocity and acceleration characteristics, of mechanisms such as linkage and cams.
2. Understand basics of gear geometry and design procedures
3. Develop the required analytical and practical capabilities to understand the dynamic working of mechanical machines that include most basic mechanisms
4. Use methods of vector kinematics to analyze the translation and rotational rigid bodies and explain with appropriate visualization.

UNIT I

Simple Mechanism: Introduction of theory of machines, definitions- statics, dynamics, kinematics, kinetics, kinematic pair, kinematic chain, mechanism, machine inversions, relation between number of links, number of joints and number of pairs, four bar chain and its inversion, Slider crank chain and its inversions.

UNIT II

Velocity and Acceleration of Points and Links: Angular and linear velocity, relative and absolute velocity, velocity in links. Instantaneous center, locating instantaneous center of rotation, velocity determination of four bar mechanism by relative velocity method, Acceleration of link centripetal and tangential, total relative and absolute acceleration. Velocity and acceleration diagrams for four bar and other mechanisms. Klein's construction for single slider crank mechanism. Analytical method of calculating the velocity and acceleration of piston in a reciprocating engine mechanism.

UNIT III

Gear and Gear Train: Introduction, classification of gears, gear terminology, law of gearing, velocity of sliding, forms of teeth – cycloid profile teeth, involutes profile teeth, path of contact, arc of contact. Interference in involutes gear, minimum no of teeth in gear and pinion

Gear Train: classification of gear train. Function of idler. Calculation of velocity ratio, train value of gear train- simple, compound epicyclic and reverted gear train, motor car gear box.

UNIT IV

Power Transmission: Drives: meaning, Classification, belt, chain, rope and gear drives. Flat and ' V ' belt, ratio of tensions. Slip length of belt calculation for open and cross belt drive. H.P. transmitted. Effect of centrifugal force, centrifugal tension, total tension maximum stress in belt. Maximum Power transmitted. Velocity for maximum H.P. condition. V-Belt drives, advantages and disadvantages of V-Belt drives. **Rope Drives:** Types, ratio of tensions, Designation of ropes as per B.I.S. **Chain Drive:** Classification, designation of chain drives as per B.I.S.

UNIT V

Cams and Followers: Need, Classification. motion of follower Displacement, velocity and acceleration diagrams uniform velocity, uniform acceleration and retardation. Simple harmonic motion. Cam profile for radial. offset knife edged follower

List of Experiments:

1. To study various types of kinematics links and kinematic pair
2. To study various types of kinematics chain and Mechanisms
3. To study inversions of Single slider crank mechanisms
4. To study inversions of 4 Bar Mechanisms
5. To study inversions of double-slider-crank
6. To study different types of steering gears
7. To study different types of Gears trains
8. To study different types of Gears
9. To study different types of cams & followers

Reference Books:

- Theory of Machines by J.M. Shah & H.M. Jadhwani.
- Theory of Machines by Abdulla Shariff
- Theory of Machines by M.R. Malhotra & H.C. Gupta. (Technical India Pub.)
- Theory of machines by P.L. Ballaney.
- Theory of Machines by Thomas Bevan.
- Theory of Machines by S. S. Ratan.
- Theory of Machines by R.S. Khurmi
- Theory of Mechanism and Machine by Jagdish Lal

Course Outcomes:

1. Understand the basics of theory of machines, mechanisms, and their inversions, including kinematic pairs and chains.
2. Analyze velocity and acceleration of points and links in mechanisms using both graphical and analytical methods.
3. Comprehend gear terminology, gear profiles, and gear trains, and calculate velocity ratios in various types of gear trains.
4. Understand the classification and motion of cams and followers, and design cam profiles for specific motion requirements.

SARDAR PATEL UNIVERSITY, BALAGHAT (MP)

School of Engineering and Technology

Syllabus

Subject: Industrial Engineering & Management, Subject Code: DME-044

Course: Diploma, Branch: Mechanical, Semester: IV

Academic Session: 2024-25

Course Content

Course Objectives:

1. Design, develop, implement and improve integrated systems that include people, materials, information, equipment and energy.
2. Apply statistical and simulation tools, optimization and meta heuristics techniques for analysis of various systems leading to better decision making.
3. Demonstrate the engineering relationships between the management tasks of planning, organization, leadership, control, and the human element in various sectors of economy.
4. Pursue entrepreneurial venture with a focus on creativity and innovation for developing newer products, processes and systems.
5. Design and develop sustainable technologies and solutions for betterment of society

UNIT I

Introduction: - Definition of industry and industrial engineering, scope and role of industrial engineering fields of applications.

Productivity: - Production and productivity, production systems and their impact on productivity, its significance and benefits of higher productivity. Long term and short-term factors affecting productivity, productivity cycle.

Production Planning and Control: Production systems, characteristics of each type, production and consumption rate. PPC functions.

UNIT II

Work Study: - Introduction, its relation with productivity aims, objectives and application of work study, basic procedure and techniques of work study. Human factors in work study.

Method Study: -Definition objectives, basic procedures of methods study. Recording techniques, operation process chart, flow process chart, machine chart, flow diagrams, string diagrams, two hand process charts.

Principles of Motion Economy: - Meaning, basic rules design of efficient work place- layout, classification of human body movements and their preferred order.

Micro Motion Study: -Definition and objectives, techniques of micromotion study, therbligs and their symbols, use of therbligs, SIMO chart and its application.

UNIT III

Work Measurement: - Definition, Basic procedure and technique to work measurement. Stop watch time study, types of stop watch study, factors considered in selecting a job for time study, qualified and representative workers, procedure of stop watch time study, job element and their need of identification, general rules for breakdown of job into elements, work cycle, methods of time measurement, performance rating, its meaning, standard rating, rating of operators, conditions for operators' variation at work place rating scales, rating factors, calculation of basic time. Allowances- purpose, types. Calculation of standard time synthesis method- meaning, data, complication, advantages and limitations

PMTS- Definition principle and use, calculation of standard time.

MIM - Meaning, tables and use. Application of MIM analysis for LH-RH charts, calculation of standard time.

Work/Activity Sampling: Definition, statistical basics, determination of number of observations for given accuracy, sources of error, application and calculation of standard time.

UNIT IV

Project Planning by Network: Network definition, objectives. CPM and PERT, activity, event, network formation, Fulkerson's rule, dependency of activities, dummy activity, duration, EST, EFT, LST, LFT, EPO, LPO, Total float and Free float.

Network analysis in tabular form.

Operation Research: Definition and concept of OR, method of OR, simple linear programming problem formulation and solution by graphical method.

UNIT V

INTRODUCTION: Definition and functions of management. Management theories - Decision, Quantitative, Mathematical and Behavioral Science.

MATERIALS MANAGEMENT: Introduction, function, purchase systems, stock turn-over, ordered quantity. Inventory, need of inventory control, EOQ and simple numerical problems on EOQ. Safety stock, different techniques of inventory control, ABC analysis (simple treatment only).

Stores management - storing procedure and store records.

Job Evaluation, Wages and Incentives: - Definition, need and scope of job evaluation. Job evaluation systems and their comparative merits and demerits and limitations.

Wage: Definition, wage components, wage fixation, real, minimum and fair wage. Financial and non- financial incentives and their examples. Wage plans- Halsey, Taylor, differential plan, Gantt task and bonus plan, 100 % premium plan.

List of Experiments:

1. Preparation of flow process chart for existing and improved process.
2. Preparation of man and machine chart for existing and improved process.
3. Preparation of L.H. and R.H. charts for existing and improved process.
4. Use of decimal minute watch.
5. Performance rating.
6. Establishing standard time for given operation using time study techniques.
7. Use of Shewhart's bowl and actual production for frequency distribution.
8. Preparation of X and R charts.
9. Preparation of p- chart and c- chart.
10. Work measurement using MOST
11. Acceptance sampling by attributes (single and double sampling plans)
12. Determination of the percentage utilization of equipment (work sampling).
13. Application of principals of motion economy

Reference Books:

- Introduction To Industrial Engineering by Philip Hicks (McGraw Hills)
- Productivity Means Property (Asian Productivity Organization, Tokyo)
- Introduction To Work Study (International Labour Office)
- Work Study by M.D. Schmid & Subramaniam
- Motion and Time Study by Ralph M. Barnes John Willey New York
- Work Study by Dalela.
- Wage Administration by D.K. Roy. (N.P.C. Publication).
- Quality Assurance Engineering by M.D. Schmid & Subramaniam.
- S.Q.C. by E.L.Grant.
- S.Q.C. by R.C. Gupta.
- Industrial Engineering & Management by O. P. Khanna.

Course Outcomes:

1. Define industrial engineering, its scope, role, and fields of application, along with the significance of productivity and factors affecting it.
2. Describe the aims, objectives, and basic techniques of work study, including method study and principles of motion economy.
3. Explain work measurement techniques, including stopwatch time study, PMTS, and MIM, as well as work/activity sampling and their applications.
4. Analyze project planning using network techniques, including CPM and PERT, and apply operations research methods to solve linear programming problems.
5. Understand the functions of management, theories of management, materials management concepts including inventory control, and job evaluation systems, along with wage and incentive plans.

SARDAR PATEL UNIVERSITY, BALAGHAT (MP)

School of Engineering and Technology

Syllabus

Subject: Principle & Practice of Management, Subject Code: DME045

Course: Diploma, Branch: Mechanical, Semester: IV

Academic Session: 2024-25

Course Content

Course Objectives:

1. Explain how firms acquire market power and how they use this market power once Acquired.
2. Analyse how competing firms interact strategically.
3. Describe the current state of knowledge in the field of industrial organisation.
4. Appreciate the strategic role of OM in creating and enhancing a firm's competitive advantages
5. Understand key concepts and issues of OM in both manufacturing and service organizations

Unit I

UNDERSTANDING MANAGEMENT: Management Fundamentals: Introduction to management, its importance, and scope. The role of managers in organizations. Evolution of Management Thought: Historical overview.

Unit II

PLANNING AND STRATEGY: Nature and Purpose of Planning: Basics of planning, its process, and various types of plans. Introduction to objectives and the Six P's of planning. Strategies and Models: Decision Making: Types of decisions, decision-making process, and rational decision making.

Unit III

ORGANIZING AND STAFFING: Organizational Structure: Introduction to organizing, departmentalization, span of control, centralization, and decentralization. Staffing: Recruitment and selection processes, career development, and stages.

Unit IV

LEADERSHIP, CREATIVITY, AND INNOVATION: Organizational Culture: Elements and types of culture, managing cultural diversity within organizations. Motivation and Leadership: Exploring their roles in business effectiveness. Creativity and Innovation:

Unit V

COORDINATION, COOPERATION, AND CONTROL: Coordination and Cooperation: Concepts, needs, and techniques for effective coordination and cooperation. Process of Controlling: Understanding types of control, including budgetary and non-budgetary control.

Reference Books:

- C. B Gupta -Management Principles
- L.M Prasad -Principles and Practices in Management
- Dinkar Paga re –Business Management
- P.C. Tripathi & P.N. Reddy – Principles of Management.
- Weinrich and Koontz – Essentials of Management; Tata McGraw

Course Outcomes:

1. Understand the fundamentals of management, its importance, scope, and the role of managers in organizations.
2. Explain the nature and purpose of planning, including the planning process and types of plans, along with decision-making strategies.
3. Analyze organizational structures, departmentalization, and the staffing process, including recruitment and career development.
4. Explore the elements of organizational culture, the roles of motivation and leadership, and the importance of creativity and innovation in business.
5. Evaluate concepts and techniques for effective coordination and cooperation, along with understanding the processes and types of control in management.

SARDAR PATEL UNIVERSITY, BALAGHAT (MP)

School of Engineering and Technology

Syllabus

Subject: CATIA Lab, Subject Code:046P

Course: Diploma, Branch: Mechanical, Semester: IV

Academic Session: 2024-25

Course Content

Course Objectives:

1. Introduce students to the CATIA software environment.
2. Develop skills in creating 2D sketches and 3D models using CATIA.
3. Enable students to understand and apply the basic tools of CATIA for part design, assembly, and drafting.
4. Provide practical exposure to industry-standard CAD software used in mechanical design.
5. Foster creativity and technical accuracy in designing mechanical components.

UNIT I

Introduction to CATIA: Overview of CATIA features and user interface. Basics of CAD and its role in mechanical design. Creating and managing projects in CATIA. Introduction to 2D sketching: Setting up planes, grids, and coordinates. Basic sketch tools: Lines, circles, rectangles, and other geometric shapes. Constraints: Applying dimensional and geometric constraints to sketches.

UNIT II

Part Design in CATIA: Introduction to 3D modeling. Basic 3D features: Extrude, revolve, and sweep. Editing features: Fillet, chamfer, and shell. Advanced modeling techniques: Loft, rib, and multi-section solids. Practice: Designing simple mechanical parts (e.g., brackets, shafts, flanges).

UNIT III

Assembly Design: Creating and managing assemblies in CATIA. Inserting and positioning components in an assembly. Applying assembly constraints: Mates, joints, and alignment. Assembly operations: Exploding assemblies and checking for interference. Practice: Assembling a mechanical product (e.g., gearbox, piston-cylinder).

UNIT IV

Drafting and Technical Documentation: Creating 2D drawings from 3D models. Generating orthographic, isometric, and sectional views. Dimensioning and tolerancing: Applying GD&T

(Geometric Dimensioning & Tolerancing). Annotations, title blocks, and bill of materials (BOM). Creating detailed engineering drawings for manufacturing.

UNIT V

Design Validation and Simulation: Introduction to CATIA analysis tools. Performing simple stress analysis on mechanical components. Motion simulation for assemblies: Kinematics and dynamics. Optimization of part design for manufacturability. Mini-project: Design, model, and analyze a simple mechanical system.

List of Experiments:

1. Introduction to CATIA Interface and Basic Sketching.
2. Creating 2D Sketches and Applying Constraints.
3. 3D Part Design: Modeling of a Bracket.
4. Assembly Design: Gearbox Assembly.
5. Drafting: Generating Views and Dimensioning.
6. Surface Design and Sheet Metal in CATIA.
7. Basic Finite Element Analysis (FEA) of a Simple Part.
8. Kinematic Simulation of a Mechanical Assembly.

Reference Books:

- CATIA V5-6R2017 for Designers by Sham Tickoo, CADCIM Technologies.
- Learning CATIA by Examples by Kaushik Kumar, Chikesh Ranjan, Nisha Kumari, LAP Lambert Academic Publishing.
- CATIA Core Tools: Computer Aided Three-Dimensional Interactive Application by Michel Michaud, Industrial Press.
- Mastering CATIA V5 by J.S. Rao, McGraw Hill Education.

Course Outcomes:

1. Understand the features, user interface, and basics of CAD in CATIA for mechanical design.
2. Develop 2D sketches using basic sketch tools and apply geometric and dimensional constraints.
3. Create 3D models using features like extrude, revolve, and sweep, and design simple mechanical parts.
4. Assemble mechanical components, apply constraints, and check for interference in assemblies.
5. Generate technical documentation including 2D drawings with GD&T, annotations, and BOM for manufacturing.