GUJARAT TECHNOLOGICAL UNIVERSITY

Bachelor of Engineering
Subject Code: 3170001
Semester –VII
Subject Name: Summer Internship

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks				Total Marks
L	T	P	C	Theory Marks		Practical Marks		
				ESE (E)	PA (M)	ESE (V)	PA (I)	
0	0	4	2	0	0	80	20	100

The duration of internship will be two weeks. It will be after completion of 6th Semester and before the commencement of Semester VII.

Following five options can be opted by the students:

1. Offline internship in industry - Internship in industry subjected to permissions from Government and concern Industry subject to the conditions of following the SOP issued by Government and written consent of the student and parents. Student is supposed to produce joining letter and relieving letter once the internship is over in case of Offline internship in any industry.
2. Online internship in industry / other agencies
3. Seminar by student under mentorship of a faculty. The topic shall be as per UG Syllabus topics
4. Preparation of consolidated report on survey of materials used in the respective branch of the student. The work should include the study of catalogues, price list specifications, properties, usage notes and other technical details and drawings etc, Work shall be carried out under the guidance of faculty. A detailed report shall be submitted. It shall be done by only one student. It is to be completed individually.
5. A Mini Project- on some suitable topic related to respective branch. It can be small fabrication / experimental results/ simulations / Programmes/ application development etc depending on the branch of the student. Preferably a single student should do it.

Other guidelines:

- Student has to prepare detailed report and submit to his/her college. A copy of report can be kept in the departments for record.
- Each student must be assigned a faculty as a mentor from the college and an Industry expert as co-mentor.
- The evaluation of the work done by students will be carried out after 2 weeks by the internal and external examiner.
- External examiner will evaluate for 80 marks and internal examiner will evaluate for 20 marks.
- The presentation by student in the presence of all student is desirable.

Student should produce successful completion certificate in case of offline / online internship in industry.

GUJARAT TECHNOLOGICAL UNIVERSITY

Bachelor of Engineering
Subject Code: 3171506
Semester –VII
Subject Name: Project Management

Type of course:

Prerequisite: Nil

Rationale:
The course aims to impart basic skills of Project management & its various aspects.

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks				Total Marks
				Theory Marks		Practical Marks		
L	T	P	C	ESE (E)	PA (M)	ESE (V)	PA (I)	
3	0	2	4	70	30	30	20	150

Content:

Sr. No.	Content	Total Hrs
1	**Project Management:** Definition of project, Project Management Vs. General Management, Three goals of project, The life cycle of projects, Selecting projects to meet organizational goals, Confronting Uncertainty, Project portfolio process, An approach to Project Formulation	08
2	**Organizing the project:** The PM's Roles, The PM's responsibility to the project, Selection of a Project Manager, Project Management as a profession, Fitting projects into the parent organization, The project team	06
3	**Planning the project:** The contents of a project plan, The planning process-overview, The planning process- Nuts and Bolts, The work breakdown structure and other aids, Multidisciplinary Teams- Balancing Pleasure and Pain,	06
4	**Budgeting the Project:** Methods of budgeting, Cost estimating, Improving Cost Estimates, Budget Uncertainty and risk management	04
5	**Project Network Theory:** Scheduling the Project PERT and CPM Networks, Project uncertainty and risk management, Simulation, The Gantt chart, Extensions to PERT/CPM.	06
6	**Allocating the Resources to the Project:** Expediting a Project, Resource Loading, Resource Leveling, Allocating Scarce resources to projects, Allocating several resources to the several projects, Goldratt's critical chain. Crashing the Project network.	04
7	**Monitoring and Controlling the Project:** The plan-monitor-control cycle, Data collection and reporting, Earned value, Project	03

	control, Designing the control system, Scope creep and change control	
8	**Evaluating and Terminating the Project:** Evaluation, Project Auditing, Project Termination	
	Total Hours	**45**

Suggested Specification table with Marks (Theory): (For BE only)

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
10	15	20	20	20	15

Legends: R: Remembrance; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create and above Levels (Revised Bloom's Taxonomy)

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

Reference Books:

1. Project Management by Samuel J. Mantel, Jr. , Jack R. Meredith, Scott M. Shafer, Margaret M. Sutton with M. R. Gopalan (WILEY-INDIA)
2. Project Management and Appraisal by Sitangshu Khatua (Oxford)

Course Outcomes: Students will be able to:

Sr. No.	CO statement	Marks % weightage
CO-1	Demonstrate the fundamentals of project management its organization.	25
CO-2	Utilize the concepts of project organizing, project planning and it's budgeting.	25
CO-3	Analyze the project network and resource allocation in projects.	20
CO-4	Illustrate the project monitoring and control.	20
CO-5	Choose evaluating and terminating the Project.	10

Term Work:
The term work shall be based on the topics mentioned above.

GUJARAT TECHNOLOGICAL UNIVERSITY

Bachelor of Engineering
Subject Code: 3171910
Semester –VII
Subject Name: Power Plant Engineering

Type of course: Professional Core

Prerequisite: Thermodynamics& Heat Transfer

Rationale: Providing an overview of Power Plants and detailing the role of Mechanical Engineers in their operation and maintenance and to address the underlying concepts, methods and application of different Thermal Power Plants.

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks				Total Marks
				Theory Marks		Practical Marks		
L	T	P	C	ESE (E)	PA (M)	ESE (V)	PA (I)	
3	0	0	3	70	30	0	0	100

Content:

Sr. No.	Content	Total Hrs
1	**Coal Based Thermal Power Plant:** Layout of modern coal power plant, site selection criteria, Rankine cycle and its improvisations, Supercritical Pressure Boilers, FBC Boilers, Steam Nozzles, Steam Turbines, Steam Condensers, Cooling Towers, Steam & Heat rate, Combined Cycle Power Plant : Binary Cycles and Cogeneration systems. Subsystems of thermal power plants – Draught system, Fuel and ash handling, Feed water treatment,	14
2	**Gas Turbine Power Plant:** Classification, Open and closed cycle, Gas turbine fuels, Actual Brayton cycle, Optimum pressure ratio for maximum thermal efficiency, Work ratio, Air rate, Effect of operating variables on the thermal efficiency and work, Cooling of gas turbine blade, Combined steam and gas turbine plant.	10
3	**Nuclear Power Plant**: Basics of Nuclear Engineering, Layout and subsystems of Nuclear Power Plants, Working of Nuclear Reactors : Boiling Water Reactor (BWR), Pressurized Water Reactor (PWR), CANada Deuterium- Uranium reactor (CANDU), Breeder, Gas Cooled and Liquid Metal Cooled Reactors, Brief about the Nuclear program in India, Safety measures for Nuclear Power plants	08
4	**Power from Renewable Energy:** Hydro Electric Power Plants – Classification, Typical Layout and associated components including Turbines. Principle, Construction and working of Wind, Tidal, Solar Photovoltaic (SPV), Solar Thermal, GeoThermal and Fuel Cell power systems	08
5	**Energy, Economic and Environmental issues of Power plants:** Power tariff types, Load distribution parameters, load curve, Comparison of site selection criteria, relative merits & demerits, Capital & Operating Cost of different power plants. Pollution control technologies including Waste Disposal Options for Coal and Nuclear Power Plants	05

Suggested Specification table with Marks (Theory):

GUJARAT TECHNOLOGICAL UNIVERSITY

Bachelor of Engineering
Subject Code: 3171910

Distribution of Theory % Marks					
R Level	U Level	A Level	N Level	E Level	C Level
25	**25**	**30**	**20**	**0**	**0**

Legends: R: Remembrance; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create and above Levels (Revised Bloom's Taxonomy)

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

Reference Books:

1. Power Plant Engineering, P.K. Nag, McGraw-Hill Education
2. Power Plant Technology, M.M. El-Wakil, McGraw-Hill Education
3. Thermal Engineering, R.K.Rajput, Laxmi Publication
4. Gas Turbines by V.Ganeshan, McGraw Hill Education
5. Steam Turbine Theory and Practice, William J. Kearton, CBS Publication

Course Outcomes:

Sr. No.	CO statement	Marks % weightage
CO-1	Explain the layout, construction and working of the components of thermal, Diesel, Gas and Combined cycle power plants.	55
CO-2	Explain the layout, construction and working of the components of Nuclear power plants.	17
CO-3	Explain the layout, construction and working of the components of Renewable Energy power plants.	18
CO-4	Explain the applications of power plants while extending their knowledge to power plant economics and environmental hazards and estimate the costs of electrical energy production.	10

List of Open Source Software/learning website:

1. http://nptel.ac.in/
2. http://npti.in/default.aspx

Industrial Visit: It is strongly suggested and recommended to arrange a visit to Thermal Power Plant/Hydro Power Plant / Nuclear Power Plant /Solar Power Plant.

GUJARAT TECHNOLOGICAL UNIVERSITY

Bachelor of Engineering
Subject Code: 3171911
Semester –7
Subject Name: Advanced Heat Transfer

Type of course: Professional Elective

Prerequisite: -

Rationale: The course is prepared to provide the detailed understanding of heat transfer through conduction, convection, radiation and phase change. This course is design to learn techniques for heat transfer enhancement and usage of numerical methods for solving heat transfer problems.

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks				Total Marks
				Theory Marks		Practical Marks		
L	T	P	C	ESE (E)	PA (M)	ESE (V)	PA (I)	
3	0	2	4	70	30	30	20	150

Content:

Sr. No.	Content	Total Hrs
1	**Conduction:** General conduction Equation, Conduction with Heat Generation, Extended Surfaces with Uniform and Non Uniform Cross Sections, Two Dimensional Steady State Conduction: Mathematical, Graphical and Numerical Analysis of Two Dimensional Heat Conduction, Unsteady State Conduction: Lumped Parameter Analysis, Numerical Solutions, Heisler and Semi Analytical Analysis	18
2	**Convection:** Different Types of Flow and Boundary Layers, Heat transfer in high velocity flow, Flow through Tubes, Flow over Flat Plates, Cylinders, Spheres and Tube Banks, Free Convection on Flat Surfaces, Cylinders, Spheres and Enclosed Spaces	08
3	**Convection with Phase change:** Boiling: Pool Boiling and its Correlations, Forced Convection Boiling**,** Condensation: Laminar and Turbulent Film Condensation, Film Condensation in Radial Surfaces and Horizontal Tubes, Heat Pipe	08
4	**Radiation:** Radiation Intensity, Blackbody Radiation, Emission from Real Surfaces Radiation Combine with Conduction and Convection, Radiation Exchange with Participating Media, Radiative exchange and overall heat transfer in furnaces	11

Suggested Specification table with Marks (Theory):

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
20	**30**	**40**	**10**	**0**	**0**

Legends: R: Remembrance; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create and above Levels (Revised Bloom's Taxonomy)

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

GUJARAT TECHNOLOGICAL UNIVERSITY

Bachelor of Engineering
Subject Code: 3171911

Reference Books:

1. Heat and Mass Transfer by P.K. Nag, McGraw Hill
2. Heat and Mass Transfer: Fundamentals and Application by YunusCengel, McGraw Hill
3. Fundamental of Heat and Mass Transfer by Incropera and Dewitt, Wiley Publication
4. Heat Transfer by Mills and Ganesan, Pearson Education
5. Heat Transfer by J P Holman, McGraw Hill

Course Outcomes:

Sr. No.	CO statement	Marks % weightage
CO-1	To analyze steady state and transient heat conduction and extended surface heat transfer problems of different thermal systems.	40
CO-2	To analyze convective heat transfer problems encountered in different thermal systems.	18
CO-3	To analyze convective heat transfer problems with phase change (boiling and condensation).	18
CO-4	To analyze radiation heat transfer problems of various thermal systems.	24

List of Experiments:

1. To analyze one-dimensional heat transfer with heat generation problems in different coordinate systems.
2. To develop analytical solution of two-dimensional heat transfer problems.
3. To develop numerical solution of two-dimensional heat transfer problems.
4. To estimate efficiency of circular, triangular and parabolic fins.
5. To estimate unsteady state heat transfer using Heisler and Grober charts for plate, cylinder and sphere.
6. To determine boiling heat transfer coefficient from a surface to a liquid.
7. To determine film and drop wise condensation heat transfer coefficient between surface and liquid.
8. To visualize the pool boiling over the heater wire in different regions up to the critical heat flux.
9. To determine effective thermal conductivity of a heat pipe.
10. To estimate radiation heat transfer with and without participating media.

Major Equipment: boiling heat transfer apparatus, film and drop wise condensation apparatus, pool boiling apparatus, heat pipe apparatus, and computer systems

List of open source software/learning website:https://nptel.ac.in/course.php

GUJARAT TECHNOLOGICAL UNIVERSITY

Bachelor of Engineering
Subject Code: 3171917
DESIGN OF MACHINE ELEMENTS
B.E. 7thSEMESTER

Type of course: Professional Core

Prerequisite: None**.**

Rationale: The course aims to impart basic skills of force and stress analysis for design of machine elements.

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks				Total Marks
L	T	P	C	Theory Marks		Practical Marks		
				ESE (E)	PA (M)	ESE (V)	PA (I)	
3	0	2	4	70	30	30	20	150

NOTE:

1. University theory exam duration is 3 hours.
2. PSG design data book is permitted during university exam.

Content:

Sr. No.	Content	Total Hrs
1	**Design Considerations** Standardization, Preferred numbers, Tolerances and Fits, Ergonomics, System design, Manufacturing considerations.	**02***
2	**Design of Coupling** Types of coupling, Design of Muff coupling, Clamp coupling, Rigid flange coupling and Bush pin type flexible coupling	**04**
3	**Spring** Types of spring, Stress and deflection equations, Design of helical spring, Concentric springs, Design of Multi-leaf spring	**05**
4	**Pressure vessels** Thin cylinder, Thin spherical vessels, Thick cylinders, Lame's equation, Clavarino's and Birnie's equations, Cylinder with external pressure, Autofrettage, Compound cylinder.	**05**
5	**Rolling contact bearings**** Types of rolling-contact bearings, Selection of bearing type, Static load carrying capacity of bearing, Dynamic load carrying capacity of bearing, Equivalent bearing load, Load-life relationship, Selection of bearing from manufacturer's catalogue, Bearing with probability of survival other than 90 percent, Design for cyclic load	**04**
6	**Sliding contact bearings**** Basic mode of lubrication, Measurement of viscosity, Viscosity index, Petroff's equation, McKee's equations, Interpretation of Reynold's equation, Difference between hydrodynamic and hydrostatic bearing, Performance parameters for journal bearings, Bearing design – selection of parameters for journal bearing	**04**
7	**Design of gear drives (Spur, Helical, Bevel and Worm)**** Classification of gears, Selection of type of gears, Standard system of gear tooth, Force analysis, Gear tooth failures, selection of material, Beam strength of gear tooth, Wear	**10**

	strength of gear tooth, Virtual number of teeth, Thermal considerations for worm gear.	
8	**Speed Gear box** Various laws of stepped Regulation, Standard values of G. P. ratio and guidelines for selecting a proper value, Break up of speed steps, Structural diagram and their analysis to select the best possible version, Speed chart, General recommendations for developing the gearing diagram, Determine the no. of teeth of gear.	**06**
9	**Design of Mechanisms** Valve gear mechanism for IC engine, Hoisting tackle analysis, Wire rope design ,Crane hook Assembly	**07**

* Topic 1 should be covered during tutorial class.

** Use PSG design data book for equations/data/chart.

Reference Books:

1. Design of Machine Elements, V B Bhandari, 3/e, Tata McGraw Hill.
2. A Textbook of Machine Design, P C Sharma and D K Aggarwal,S K Kataria & sons.
3. Shigley's Mechanical Engineering Design, R G Budnyas, J K Nisbett, McGraw Hill.
4. Fundamentals of Machine Component Design, R C Juvinall, 4/e, Wiley.
5. Machine Design: An Integrated Approach, R L Norton, Pearson
6. Machine Tool Design and Numerical Control, N K Mehta, Tata McGraw Hill Edu.
7. Design Data, Faculty of Mechanical Engineering, PSG College of Engineering, Coimbatore.

Distribution of marks weightage for cognitive level

Bloom's Taxonomy for Cognitive Domain	Marks % weightage
Recall	10
Comprehension	10
Application	25
Analysis	45
Evaluate	5
Create	5

Course Outcome:

After learning the course the students will be able to:

Sr. No.	CO statement	Marks % weightage
CO-1	Relate various standard used in industry and utilize knowledge of manufacturing process in design of machine elements.	05

CO-2	Determine forces acting on machine elements like couplings, springs, gears, bearings and perform stress analysis for machine components.	40
CO-3	Estimate life of rolling element bearings and determine performance parameters of sliding contact bearings.	15
CO-4	Evaluate speed variation on gear box shafts and optimize fluctuation of shaft speeds in gear box.	10
CO-5	Design and dissect mechanisms for strength and improve their life.	30

List of Experiments:

Experiments should cover all topics discussed in subject content. Like.

1. Design of rigid and flexible couplings.
2. Design of helical and leaf springs.
3. Design of two stage gear box including gear design, bearing selection.
4. Design of pressure vessels.

Major Equipment:

Computational facility.

List of Open Source Software/learning website:

http://nptel.ac.in

GUJARAT TECHNOLOGICAL UNIVERSITY

Bachelor of Engineering
Subject Code: 3171918
Semester –7
Subject Name: Refrigeration and Air-conditioning

Type of course: Professional Elective

Prerequisite: -

Rationale: The course is designed to give fundamental knowledge of types of refrigeration, refrigeration cycles, refrigerants and their behavior under various conditions, air conditioning load calculation and designing of components of air distribution system.

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks				Total Marks
				Theory Marks		Practical Marks		
L	T	P	C	ESE (E)	PA (M)	ESE (V)	PA (I)	
3	0	2	4	70	30	30	20	150

Content:

Sr. No.	Content	Total Hrs
1	**Introduction and Refrigerant**: Brief history and need of refrigeration and air conditioning, methods of producing cooling, ton of refrigeration, coefficient of performance, types and application of refrigeration and air condensing systems, Recapitulation of desirable properties of refrigerants, secondary refrigerants, future industrial refrigerants	4
2	**Air refrigeration:** Aircraft refrigeration, working and analysis of Simple, Bootstrap, Reduced ambient and Regenerative air refrigeration systems	5
3	**Compound Compression VCR system:** Multiple evaporators with back pressure valves and with multiple expansion valves without flash inter cooling, analysis of two evaporators with flash intercooler and individual expansion valve and multiple expansion valve, cascade refrigeration system	7
4	**Absorption refrigeration system:** Practical H_2O -NH_3 cycle, LiBr – H_2O system and its working, h-x diagram and simple calculation of various process like adiabatic mixing and mixing with heat transfer, throttling	6
5	**Refrigeration system components:** Types, construction, working, comparison and selection of compressors, condensers, expansion devices and evaporators; refrigeration piping accessories, evacuation and charging of refrigerant, properties and classification of thermal insulation	4
6	**Human comfort and Load analysis:** Selection of inside design conditions, thermal comfort, heat balance equation for a human being, factors affecting thermal comfort, Effective temperature, comfort chart and factors governing effective temperature, selection of outside design conditions Site survey, outdoor and indoor design conditions, classification of loads, flywheel effect of	9

	building material and its use in design, effect of wall construction on cooling load, instantaneous heat gain (IHG) and instantaneous cooling load (ICL) heat transmission through sunlit and shaded glass using tables, method of reduction of solar heat gain through glass, calculations of cooling load TETD due to sunlit and shaded roof and walls using tables, ventilation and air infiltration, load due to outside air, heat gain from occupants; electric lights; product; electric motor and appliances, load calculations for automobiles, use of load estimation sheet	
7	**Duct design and air distribution:** Function; classification and economic factors influencing duct layout, equal friction, velocity reduction and static regain methods of duct design, use of friction chart, dynamic losses and its determination, Requirements of air distribution system, air distribution, grills, outlets, application, location	6
8	**Air-conditioning systems:** Classification, system components, all air; all water; and air-water systems, room air conditioners, packaged air conditioning plant, central air conditioning systems, split air conditioning systems	4

Suggested Specification table with Marks (Theory):

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
20	**20**	**40**	**20**	**0**	**0**

Legends: R: Remembrance; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create and above Levels (Revised Bloom's Taxonomy)

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

Reference Books:

1. Refrigeration and Air Conditioning by C P Arora, McGraw-Hill India Publishing Ltd.
2. Refrigeration and Air-conditioning by Ramesh Arora , Prentice Hall of India
3. Refrigeration and Air Conditioning by Manohar Prasad, New Age International Publisher
4. ASHRAE Handbook – Fundamentals 2017, ASHRAE
5. Automobile Air conditioning by Crouse and Anglin, McGraw Hill Publications

Course Outcomes:

Sr. No.	CO statement	Marks % weightage
CO-1	To select proper refrigerant for various applications and make basic calculations of aircraft refrigeration.	20
CO-2	To analyze multi-evaporator systems and simple vapor absorption systems.	28
CO-3	To explain construction and working of different refrigeration system components.	09
CO-4	To solve air-conditioning load calculations for buildings and automobiles.	20
CO-5	To select proper air-conditioning system for various applications and construct duct layout for the systems.	23

List of Experiments:

1. To analyze multi-evaporator systems with different configurations.
2. To analyze cascade refrigeration system.
3. To analyze NH_3-H_2O system for specific application.
4. To analyze LiBr-H_2O system for specific application.
5. To understand construction and working of reciprocating, rotary and centrifugal compressor used for R&AC.
6. To understand various tools used for refrigeration tubing and to perform various operations like flaring, swaging, bending, brazing etc.
7. To calculate cooling load of a confined space using table and compare the same with load estimation sheet.
8. To design duct layout of the confined space selected for above.
9. To select and analyze proper air-conditioning system for the confined space selected above.
10. To calculate cooling load of an automobile.

Major Equipment: cut-sectional models of various types of compressors, condensers and evaporators used in R&AC industry, thermostatic expansion valve, automatic expansion valve, capillary tubes, tools for refrigeration tubing

List of open source software/learning website: https://nptel.ac.in/course.php

GUJARAT TECHNOLOGICAL UNIVERSITY

Bachelor of Engineering
Subject Code: 3171919
Semester – VII
Subject Name: Cryogenics Engineering

Type of course: Elective

Prerequisite: Basic knowledge of thermodynamics, Heat transfer, Refrigeration and Air conditioning

Rationale: The course is designed to give fundamental knowledge of types of cryogenic engineering, fluids, behavior of materials and properties at low temperature, cryogenic hazards and prevention, safety, cryogenic refrigeration and liquefaction, insulation, system requirement and measuring instruments

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks				Total Marks
				Theory Marks		Practical Marks		
L	T	P	C	ESE (E)	PA (M)	ESE (V)	PA (I)	
3	0	2	4	70	30	30	20	150

Content:

Sr. No.	Content	Total Hrs
1	**Introduction:** Cryogenic engineering, Properties of Cryogenic Fluids like Oxygen, Nitrogen, Argon, Neon, Florin, Helium, Hydrogen; Properties of Cryogenic Materials - mechanical, thermal, and electrical; Super conductivity; Hazards and prevention – physical hazard, chemical hazard, physiological hazard and preventions, Safety in cryogenic fluid handling, storage and use.	8
2	**Applications of cryogenic systems**: Super conductive devices such as bearings, motors, cryotrons, magnets, D.C. transformers, tunnel diodes, space technology, space simulation, cryogenics in biology and medicine, food preservation and industrial applications, nuclear propulsions, chemical propulsions.	8
3	**Cryogenic Refrigeration & Liquefaction**: **Refrigeration:** Ideal isothermal and reversible isobaric source refrigeration cycles, Joule Thomson system, cascade or pre-cooled joule–Thomson refrigeration systems, COP, FOM **Liquefaction:** Introduction, Principle and Methods of production of low temperature	10

	thermodynamically ideal systems, Joule Thomson effect, liquefaction systems such as Linde Hampton, Precooled Linde Hampson, Claude System	
4	**Cryogenic insulation:** Various types such as expanded foams, gas filled & fibrous insulation, vacuum insulation, evacuated powder & fibrous insulation, opacified powder insulation, multi-layer insulation, comparison of performance of various insulations.	**6**
5	**Cryogenic System Requirements:** Cryogenics Heat Exchangers, Compressors, Expanders, Effect of various parameters in performance and system optimization, Storage equipment for cryogenic fluids, industrial storage and transfer of cryogenic fluids	**8**
6	**Cryogenic instrumentation:** Properties and characteristics of instrumentation, strain displacement, pressure, flow, liquid level, density and temperature measurement in cryogenic range.	**5**

Suggested Specification table with Marks (Theory):

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
20	**30**	**40**	**10**	**0**	**0**

Legends: R: Remembrance; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create and above Levels (Revised Bloom's Taxonomy)

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

Reference Books:

1. Cryogenic systems-Baron, McGraw-Hill book
2. Cryogenic fundamentals-Haselden, Academic press New York
3. Cryogenic technology –Vance
4. Cryogenic engineering –T. M. Flynn
5. Cryogenic engineering –Scott
6. Low Temperature Superconductivity & Superconductivity By Christian Enss & Siegfried Hunklinger

GUJARAT TECHNOLOGICAL UNIVERSITY

Bachelor of Engineering
Subject Code: 3171919

Course Outcomes:

Sr. No.	CO statement	Marks % weightage
CO-1	Basic knowledge of cryogenics, materials, fluids, hazard & safety	19
CO-2	Production of low temperature	24
CO-3	Design of cryogenic systems	33
CO-4	Cryogenic applications	14
CO-5	Cryogenic instrumentations	10

List of Experiments:

1. Study of cryogenic properties of hydrogen and helium.
2. Study of low temperature measurement instrument.
3. Study of flow measurement and quality measurement instrument.
4. Study of liquid level measurement.
5. Study of insulation used in cryogenic equipment.
6. Study of cryogenic application (superconductivity)
7. Study of cryogenic application in space technology.
8. Study of cryogenic application in bio medical and food preservation.
9. Study of safety while handling fluid.
10. Study of ideal liquefaction system

GUJARAT TECHNOLOGICAL UNIVERSITY

Bachelor of Engineering

Subject Code: 3171920

SUBJECT NAME: Finite Element Methods

B.E 7th SEMESTER

Type of Course: - Professional Elective

Pre-requisite:-

Rationale: The course aims to impart basic skills of formulation and application of finite element methods for the analysis of mechanical systems.

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks				Total Marks
				Theory Marks		Practical Marks		
L	T	P	C	ES (E)	PA (M)	ESE (V)	PA (I)	
3	0	2	4	70	30	30	20	150

CONTENT:-

Sr. No.	Course Content	Total Hours
1	**Fundamental Concepts** Introduction, Stresses and Equilibrium, Boundary Conditions, Strain—Displacement Relations, Stress—Strain Relations, Temperature Effects, Potential Energy and Equilibrium: The Rayleigh—Ritz Method, Potential Energy, Rayleigh—Ritz Method, Galerkin's Method, Saint Venant's Principle, Von Mises Stress , Principle of Superposition, Matrix Algebra and Gaussian Elimination, Conjugate Gradient Method for Equation Solving, Conjugate Gradient Algorithm	**05**
2	**One-Dimensional Problems** Introduction ,Finite Element Modeling ,Element Division, Numbering Scheme, Shape Functions and Local Coordinates , The Potential-Energy Approach, Element Stiffness Matrix, Force Terms, The Galerkin Approach, Element Stiffness, Force Terms, Assembly of the Global Stiffness Matrix and Load Vector , Properties of **K** , The Finite Element Equations: Treatment of Boundary Conditions, Types of Boundary Conditions, Elimination Approach, Penalty Approach, Multipoint Constraints, Quadratic Shape Functions Temperature Effects, Problem Modeling and Boundary Conditions, Problem in Equilibrium, Symmetry, Two Elements with Same End Displacements, Problem with a Closing Gap	**09**
3	**Trusses** Introduction ,Plane Trusses, Local and Global Coordinate Systems, Formulas for Calculating I and m, Element Stiffness Matrix, Stress Calculations, Temperature Effects, Three-Dimensional Trusses, Assembly of Global Stiffness Matrix for the Banded and Skyline Solutions, Assembly for Banded Solution, Skyline Assembly, Problem Modeling and Boundary Conditions, Inclined Support in Two Dimensions, Inclined Support in Three Dimensions–Line Constraint, Inclined Support in Three Dimensions–Plane Constraint, Symmetry and Antisymmetry	**09**
4	**Beams and Frames** Introduction, Potential-Energy Approach, Galerkin Approach, Finite Element Formulation, Element Stiffness–Direct Approach, Load Vector, Boundary Considerations, Shear Force and Bending Moment, Beams on Elastic Supports, Plane Frames, Three-Dimensional Frames, Problem Modeling and Boundary Conditions	**06**
5	**Two-Dimensional Problems using Constant Strain Triangles** Introduction , Finite Element Modeling, Constant Strain Triangle (CST), Isoparametric Representation, Potential-Energy Approach, Element Stiffness, Force Terms, Integration	**08**

	Formula on a Triangle, Galerkin Approach, Stress Calculations, Temperature Effects, Problem Modeling and Boundary Conditions, Some General Comments on Dividing into Elements, Patch Test and Convergence, Patch Test, Orthotropic Materials, Temperature Effects.	
6	**Axisymmetric Solids Subjected to Axisymmetric Loading** Introduction, Axisymmetric Formulation, Finite Element Modeling: Triangular Element, Potential-Energy Approach, Body Force Term, Rotating Flywheel, Surface Traction, Galerkin Approach, Stress Calculations, Temperature Effects, Problem Modeling and Boundary Conditions, Cylinder Subjected to Internal Pressure, Infinite Cylinder, Belleville Spring, Thermal Stress Problem	**07**
	Total	**45**

Reference Books:

1. Introduction to Finite Elements in Engineering, Chandrupatla T. R. and Belegunda A. D., PHI.
2. A First Course in Finite Elements, Jacob Fish, Ted Belytschko, John Wiley & Sons Ltd
3. An Introduction to Finite Element Method, J N Reddy, McGraw - Hill.
4. Concepts and Applications of Finite Element Analysis, R D Cook, Wiley India.

Distribution of marks weightage for cognitive level

Bloom's Taxonomy for Cognitive Domain	Marks % weightage
Recall	10
Comprehension	10
Application	30
Analysis	40
Evaluate	10
Create	--

Course Outcome:

After learning the course the students will be able to:

Sr. No.	CO statement	Marks % weightage
CO-1	Demonstrate the concepts of finite element methods and its application in the field of mechanical engineering.	20
CO-2	Analyse one dimensional and two dimensional systems using finite element methods.	40
CO-3	Make use of finite element methods for analysis of trusses, beams, frames and axisymmetric solids.	30
CO-4	Estimate thermal stresses of machine elements.	10

List of Experiments:

1. Introduction to Finite Element Analysis software.
2. Solve 1D – Structural, thermal and fluid problems using FEA software and manually.
3. Solve Plane truss problems, using FEA software and manually. Include problems with symmetry.
4. Solve Beam problems with different boundary and loading conditions using FEA software and manually.
5. Solve planar problems.
6. Solve axisymmetric problems.

Major Equipment:

1. Computational facility and FAE solvers.

List of Open Source Software/learning website:

1. http://nptel.ac.in

GUJARAT TECHNOLOGICAL UNIVERSITY

Bachelor of Engineering
Subject Code: 3171921
Semester – VII
Subject Name: METAL FORMING ANALYSIS

Type of course: Professional Elective

Prerequisite: Nil

Rationale:
In present era it is highly essential to be able to prepare final product with minimum wastage and good surface quality. This is desirable to ensure that all the expected requirement of product are addressed and if required, its performance is also assessed . Metal forming offers a convenient option for manufacturing of product.

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks				Total Marks
L	T	P	C	Theory Marks		Practical Marks		
				ESE (E)	PA (M)	ESE (V)	PA (I)	
3	0	2	4	70	30	30	20	150

Content:

Sr. No.	Content	Total Hrs
1	Introduction to hot forming, cold forming, warm forming its advantages and disadvantages Typical stress strain diagram for ductile materials Forming properties of metals and alloys (yield strength/flow stress,ductility, strain hardening, strain rate sensitivity, effect of temperature and hydrostatic pressure on yield strength) Classification of forming processes and advantages of metal forming.	02
2	Stress of stress at a point, stresses on an inclined plane, Principal stress, Two dimensional Mohr's circle for stress analysis, Deformation and strain, Stress of strain at a point.Yield conditions, Von Mises' hypothesis of yielding, Tresca's hypothesis of yielding, graphical representation of yield criteria, Elastic stress strain relations for isotropic elastic materials, Idealized stress strain relations in plastic deformations, Isotropic and kinematic work hardening	08
3	Introduction to; (i). Theory of slip lines, (ii). upper bound theorem and (iii). lower bound theorem	03
4	FORGING processes: Introduction, classification of forging, forging machines, metal flow in forging, Analysis of plane strain compression, analysis of compression of circular disc	06

	with slab method	
5	EXTRUSION Processes: Introduction, calculation of extrusion load using slab method, slip line method & upper bound method. Defects in extrusion. Direct & indirect extrusion. WIRE DRAWING Processes: Introduction, defects, maximum possible reduction. Wire drawing load calculation using slab method.	**06**
6	ROLLING Processes: Classification, types of mill, Analysis of longitudinal strip or sheet rolling process (calculation of roll separating force, torque & power, angle of bite, maximum reduction in rolling), rolling defects, roll flattening, roll camber	**06**
7	SHEET METAL FORMING Processes: various sheet metal operations, Blanking and punching operations, compound and progressive dies, nesting, clearance, forces in blanking, Bending of plates, bendability, spring back, bending force, bending moment for real material, stress and strain in bending, stress in deep drawing, drawability. drawing load, Anisotropy in sheetmetal	**10**
8	Introduction to forming limit diagram, Friction and lubrication in forming processes	**04**
	Total Hours	**45**

Suggested Specification table with Marks (Theory):

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
20	**10**	**10**	**10**	**10**	**10**

Legends: R: Remembrance; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create and above Levels (Revised Bloom's Taxonomy)

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

Reference Books:

1.Ghosh A. and Mallik A. K., "Manufacturing Science", East -West Press, New Delhi, 1998.

2. Juneja B. L., "Fundamentals of Metal Forming Processes", New Age International Publishers, 2010.

3. Hosford William F. and Caddell R. M., "Metal Forming Mechanics and Metallurgy",

Prentice Hall, 1993.

4. Mielnik Edward M., "Metal Working Science and Engineering", McGraw Hill, 1991.

5. Dieter G. E., "Mechanical Metallurgy", McGraw Hill, 1988.

6. Rao P.N., "Manufacturing Technology", Tata McGraw Hill, 1990.

7. Wangoner Robert H. and Jean-Loup Chenot, "Fundamentals of Metal Forming", John Wiley & Sons, 1997.

8. Beddoes J. and Bibby M. J., "Principles of Metal Manufac turing Processes", Viva Books, 2000.

9. Sharma P. C., "Production Engineering", S. Chand & Co ., New Delhi, 2003

Course Outcomes:

Sr. No.	CO statement	Marks % weightage
CO-1	Classify various forming process	10
CO-2	Analyse theory of stress strain	15
CO-3	Identify and analyse various methods bulk metal forming processes	40
CO-4	Analyse sheet metal forming processes	25
CO-5	Evaluate forming limit diagram	10

List of Experiments:

Experiments based on above contents and should include below mentioned topics.

1. To construct a slip-line net for upsetting a work piece.

2. Experimental determination of stress strain behavior for ductile material and to evaluate the various elastic and plastic constants.

3. To analyze flow stress of the given material and to plot a graph of forging ratio vs. flow stress.

4. Plot the bulge profile of the forged pieces, to find the radius of curvature of bulging of the forged pieces and to plot a graph of forging ratio vs. Hf / Rc.

5. To analyze the bending force vs. bending angle for ‘V’ bending of strip and to plot the strain distribution.

6. SHEET METAL FORMING Processes: various sheet metal operations, Blanking and punching operations, compound and progressive dies, nesting, clearance, forces in blanking, Bending of plates, bendability, spring back, bending force, bending moment for real material, stress and strain in bending, stress in deep drawing, drawability. drawing load, Anisotropy in sheetmetal

7. Introduction to forming limit diagram, Friction and lubrication in forming processes

8. To measure the force required in extrusion of model material by using a die having different diameter and to draw the graphs between extrusion force vs. extrusion ratio.

9. To study the rolling process and plot the graph for percentage reduction in area vs. power in rolling.

10. Industrial visits for exposer to various metal forming process and report preparation based on observations and learning.

Design based Problems (DP)/Open Ended Problem:

1. Review of various methods for experimental measurements of friction in metal forming processes.

2. To plot the forming limit diagram and to study the effect of various strain paths on formability

3. To review research paper on experimental strain measurement in sheet metal forming processes

List of Open Source Software/learning website:

1. Code_Aster

2. AutoForm

3. CalculiX

4. www.nptel.ac.in

GUJARAT TECHNOLOGICAL UNIVERSITY

Bachelor of Engineering
Subject Code: 3171922
Semester – VII
Subject Name: Automation in Manufacturing

Type of course: Professional Elective

Prerequisite: Nil

Rationale:
The aim of present course is to introduce the students about the basic automation theory and understanding of its devices. Students can think and get innovative idea in the area of shop floor automation. This subject is useful to understand the different types of automation and production system used in industries

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks				Total Marks
				Theory Marks		Practical Marks		
L	T	P	C	ESE (E)	PA (M)	ESE (V)	PA (I)	
3	0	2	4	70	30	30	20	150

Content:

Sr. No.	Content	Total Hrs
1	**Introduction:** Automation and types, Automated Manufacturing System, Reasons for Automating, the USA Principle, Strategies for automation and process improvement, automation migration strategies, levels of automations, Types of Automations.	04
2	**GROUP TECHNOLOGY:** Part family, Part classification and coding, production flow analysis – OPITZ classification system, cellular manufacturing, quantitative analysis in cellular manufacturing. Rank Order Clustering Technique (ROC), Holier Method –I,II, Single Linkage Cluster Analysis Technique(SLCA). Application of group technology	06
3	**Flexible Manufacturing Systems:** Types of flexibility, types of FMS, FMS components, FMS Components-Workstations, Material Handling and Storage Systems, Computer Control System, Human Recourses, FMS Applications and Benefits., Quantitative analysis of FMS, Sizing the FMS, System performance measure. Automated Material Handling & Storage: Functions, Types, Analysis of material handling equipment, Design of Conveyor & AGV systems. Problems. Development for total material handling system.	08
4	**Pneumatic and Hydraulic System Design:** Introduction, pneumatics and hydraulic system components, pneumatics and hydraulic actuators, application of pneumatics and hydraulic system in automation, pneumatics and hydraulic circuit design for automation, limitations of pneumatics and hydraulic system.	08

5	**Industrial Robotics and Mechatronics System:** Introduction, Robot Anatomy and Related Attributes, Robot Control Systems, End Effectors, Sensors in Robotics, Industrial Robot Applications, Robot Programming overview. Transducers, Sensors and Actuators: Classification, Principle of Operation, Selection Criteria, Signal Conditioning, Calibration	**04**
6	**Automated Machinery:** Introductions, Automated transfer machine, automated transfer line, auto-storage and retrieval system, automated guided vehicles, automated material handling system, automated inspection system and CMM.	**06**
7	**Modular Automation Design:** Introduction to modular design, modular automations, Case study for modular design: 1. Casting shop design, 2. Press working shop design, 3. Machine shop design.	**04**
8	**Automation Economy:** Plant Economy, feasibility of automation on economical sense, effect of automation on economy, feasibility of automation in Indian market, Scope of automation in Indian industries, Break Even point analysis for automation.	**05**
	Total Hrs	**45**

Suggested Specification table with Marks (Theory):

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
10	**15**	**40**	**25**	**5**	**5**

Legends: R: Remembrance; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create and above Levels (Revised Bloom's Taxonomy)

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

Reference Books:

1. Automation, Production Systems and Computer Integrated Manufacturing by Mikell P. Groover, P.H.I. Learning Private Limited.

2. Hydraulics and Pneumatics by Andrew Parr, JAICO Publishing Home, Ahmedabad

3. Industrial Automation and Robotics by Er. A. K. Gupta and S. K. Arora, University Science Press, Laxmi Publishing Pvt. Ltd.

4. Robotics and Control by R. K. Mittal and I. J. Nagrath, McGraw Hill Education (India) Private Limited.

GUJARAT TECHNOLOGICAL UNIVERSITY

Bachelor of Engineering
Subject Code: 3171922

Course Outcomes:

Sr. No.	CO statement	Marks % weightage
CO-1	Overall understanding of automated systems integration using CIM	20
CO-2	Identify scope of automation in shop floor: Casting, Machine shop and Press work	25
CO-3	Understand working of different sensors and actuator and find application for industrial automation	20
CO-4	Design small automated system	15
CO-5	Application of group technology and FMS	20

List of Experiments:

Experiments based on above contents and should include below mentioned topics.

1. To study the fundamentals of automation and its types.
2. Study and report on Pneumatic Automation system.
3. Study and report on Hydraulic Automation system.
4. . Study and report on micro controller and its application.
6. Study and report on Industrial Robotics: Sensors and Actuators
7. Study and report on Different Automated Machinery
8. Study and report on Modular Automation System: Casting shop, Machine shop, Press Shop
9. Study and report on Economic analysis of Automation

List of Open Source Software/learning website:

1. www.nptel.ac.in

GUJARAT TECHNOLOGICAL UNIVERSITY

Bachelor of Engineering
Subject Code: 3171923
Semester –VII
Subject Name: Internal Combustion Engine

Type of course: Professional Core

Prerequisite: Zeal to learn the subject and Basics of Thermodynamics

Rationale: The course aims at providing fundamental knowledge of internal combustion engines. The principles that govern engine operation and working are discussed. The course is a basic course in Internal Combustion Engines that provides the student with sufficient knowledge to take active part in design and development work within the automotive industry.

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks				Total Marks
L	T	P	C	Theory Marks		Practical Marks		
				ESE (E)	PA (M)	ESE (V)	PA (I)	
3	0	2	4	70	30	30	20	150

Content:

Sr. No.	Content	Total Hrs
1	**Introduction:** Comparison of SI and CI Engines, Difference in thermodynamic and operating variables, comparison of performance characteristics, comparison of initial and maintenance costs application of SI and CI engine.	04
2	**Fuels and its supply system for SI and CI engine:** Important qualities of IC engine fuels, rating of fuels**,** Carburetion, mixture requirement for different loads and speeds, simple carburetor and its working, types of carburetors, MPFI, types of injection systems in CI engine, fuel pumps and injectors, types of nozzles, spray formation.	06
3	**Combustion in SI and CI Engines**: Combustion equations, calculations of air requirement in I C Engine, stoichiometric air fuel ratio, proximate and ultimate analysis, enthalpy of formation, adiabatic flame temperature. Stages of combustion in SI engines, abnormal combustion and knocking in SI engines, factors affecting knocking, effects of knocking, control of knocking, combustion chambers for SI engines, Stages of combustion in CI engines, detonation in C.I. engines, factors affecting detonation, controlling detonation, combustion chamber for SI and CI engine	08
4	**Engine lubrication:** Types of lubricants and their properties, SAE rating of lubricants, Types of lubrication systems **Engine Cooling:** Necessity of engine cooling, disadvantages of overcooling, Cooling systems and their comparison: Air cooling, Liquid cooling **Supercharging/Turbo-charging:** Objectives, Limitations, Methods and Types, Different arrangements of turbochargers and superchargers	07
5	**Rating, Testing and Performance:** Measurements of speed, air flow, fuel consumption,	08

	indicated power brake power, frictional horse power, and smoke, testing of engines as per Indian Standard 10001, performance test for variable speed I C Engines, heat balance sheet, governing test for constant speed IC engines, effect of fuel injection parameters in CI engines and ignition advance of SI engines on performance of engine. Rating of internal combustion engine based on (I) continuous operation of engine (II) Maximum power an engine can develop (III) Power calculated from empirical formula, Trouble Shooting and Overhauling of Engines.	
6	**Emission of IC engine:** Emission from SI engine, effect of engine maintenance on exhaust emission control of SI engine, diesel emission, diesel smoke and control, diesel and control comparison of gasoline and diesel emission. Measurement and calculation for of emission constituents.	06
7	**Unconventional Engines &Alternative Fuels for IC Engine:** Working principle of stratified charge engines sterling engine, Wankel engine Methanol, Ethanol, vegetable oils, bio gas, bio-fuels, hydrogen and comparison of their properties with Diesel and petrol.	06

Suggested Specification table with Marks (Theory):

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
30	**30**	**30**	**10**	**0**	**0**

Legends: R: Remembrance; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create and above Levels (Revised Bloom's Taxonomy)

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

Reference Books:

1. I. C. Engines by Heywood.
2. I. C. Engines by Mathur& Sharma, Dhanpatrai
3. I. C. Engines by V.Ganeshan, Tata McGraw Hill
4. I. C. Engines by Domkundwar&Domkundwar, Dhanpatrai
5. I. C. Engines by R.K.Rajput, LaxmiPrakashan

Course Outcomes:

Sr. No.	CO statement	Marks % weightage
CO-1	Describe and explain the major phenomena going on in an internal combustion engine such as gas exchange, combustion and emissions formation/reduction.	40
CO-2	Explain the performance and evaluation of internal combustion engine and to discuss how this is affected.	35
CO-3	Reflect on the role of internal combustion engines for transports in society as well as the emissions issue from both a sustainable and ethical perspective.	10
CO-4	To aware about the alternative fuels and their properties.	10
CO-5	To brief the latest development of unconventional engines.	5

GUJARAT TECHNOLOGICAL UNIVERSITY

Bachelor of Engineering
Subject Code: 3171923

List of Experiments:

1. To demonstrate various engines and their components.
2. Demonstration of valve timing diagram
3. To demonstrate about the fuel injection system for C.I. Engine
4. To demonstrate about carburetor and its types.
5. To carry out the performance analysis of single cylinder two stroke petrol engine.
6. To carry out the performance analysis of multi cylinder four stroke petrol engine.
7. To carry out the performance analysis of multi cylinder four stroke diesel engine.
8. To carry out various Performance tests: Morse Test and William Line Plot

Major Equipment:
Internal combustion engines, Bomb calorimeter, Junker gas calorimeter

List of Open Source Software/learning website: https://nptel.ac.in/course.php

GUJARAT TECHNOLOGICAL UNIVERSITY

Bachelor of Engineering
Subject Code: 3171924
Semester – VII
Subject Name: Principles of Combustion

Type of course: Professional Elective

Prerequisite: Zeal to learn the subject

Rationale: Applications of combustion exist in many field of Mechanical Engineering and therefore basic course on combustion may be helpful to the interested ones.

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks				Total Marks
				Theory Marks		Practical Marks		
L	T	P	C	ESE (E)	PA (M)	ESE (V)	PA (I)	
3	0	2	4	70	30	30	20	150

Content:

Sr. No.	Content	Total Hrs
1	**Combustion and Thermochemistry:** Introduction, Heat of reaction and formation, Free energy and the equilibrium constants, Flame temperature calculations – Analysis & Practical considerations, Sub and supersonic combustion thermodynamics – Comparisons & Stagnation pressure considerations	4
2	**Chemical Kinetics:** Introduction, Rates of reactions and their temperature dependence - The Arrhenius rate expression & Transition state and recombination rate theories, Simultaneous interdependent reactions, Chain reactions, Pseudo-first-order reactions and the "fall-off" range, The partial equilibrium assumption, Pressure effect in fractional conversion, Chemical kinetics of large reaction mechanisms – Sensitivity analysis, Rate of production analysis, Coupled thermal and chemical reacting systems & Mechanism simplification	10
3	**Chemical and Thermal Systems:** Constant pressure fixed mass reactor, constant volume reactor, well stirred reactor, plug flow reactor, application to combustion system modelling	6
4	**Conservative Equations:** Mass conservation, Species mass conservation, Multi component diffusion, momentum conservation, Energy conservation, Conserved Scalar Concept	6
5	**Laminar Flames:** Laminar Premixed Flames - Physical Description, Simplified Analysis, Detailed analysis Factors influencing flame velocity and thickness, flame stabilization, ignition Laminar Diffusion Flames – non reacting constant density laminar jet, jet flame, flame lengths, soot formation and destruction, counter flow flames	10
6	**Turbulent Flames:** Applications of turbulent flames, Definition of turbulent flame speed, structure of turbulent premixed flames, wrinkled flame regime, flamelets, flame stabilization, Jet Flames	9

GUJARAT TECHNOLOGICAL UNIVERSITY

Bachelor of Engineering
Subject Code: 3171924

Suggested Specification table with Marks (Theory):

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
20	**20**	**40**	**20**	**-**	**-**

Legends: R: Remembrance; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create and above Levels (Revised Bloom's Taxonomy)

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

Reference Books:

1. An Introduction to Combustion, Concepts and Applications, Stephen R. Turns, McGraw-Hill Education
2. Combustion, Irvin Glassman, Academic Press
3. Combustion Theory, Forman A Williams, Addison-Wesley
4. Combustion Physics, C.K. Law, Cambridge University Press
5. Combustion, Flames and Explosions of Gases, Bernard Lewis and Guenther von Elbe, Academic Press
6. Chemical Kinetics, Keith Laidler, Harper and Row

Course Outcomes:

Sr. No.	CO statement	Marks % weightage
CO-1	To comprehend combustion, types of flames and effect and control of combustion	10
CO-2	To apply the theories of chemical equilibrium	23
CO-3	To mass, momentum and energy conservation to combustion process and make calculations of various reactors	24
CO-4	To apply concepts of laminar premixed and diffusion flames to appropriate reactive systems	23
CO-5	To apply concepts of turbulent flames to appropriate reactive systems	20

List of Experiments:

1. Find the smoke point of different fuels.
2. Find the pour point and cloud point of various lubricants.
3. Test the performance of fuel pump with fuel pump test rig.
4. Study of various spray characteristics of fuel.
5. Study of flame stabilization at different equivalence ratio.
6. Study of laminar premixed flames.
7. Study of turbulent flames.
8. Model different H_2/O_2 mechanism and find equilibrium temperatures at different equivalence ratios.

Major Equipment: Fuel pump test rig, Bunsen Burner, Temperature measurement apparatus, Fuel supply system, Ignition system

List of Open Source Software/learning website: https://nptel.ac.in/course.php

GUJARAT TECHNOLOGICAL UNIVERSITY

Bachelor of Engineering
Subject Code: 3171925
Advanced Machine Design
B.E. 7thSEMESTER

Type of course: Departmental elective

Prerequisite: None

Rationale: The course aims to impart basic knowledge of fracture mechanics, surface failure and failure of machine elements under creep ,fatigue and multiaxial stresses.

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks				Total Marks
L	T	P	C	Theory Marks		Practical Marks		
				ESE(E)	PA (M)	PA (V)	PA (I)	
3	0	2	4	70	30	30	20	150

Content:

Sr. No.	Topics	Teaching Hrs.
1	**Fracture Mechanics:** Introduction, Rise in stresses due to crack, Crack tip opening displacement, LEFM: Effect of crack on strength of ductile and brittle material, Crack opening modes and Griffith theory,Conceptof *SIF* and *K* Crack Tip Plasticity, Use of *K* in design and analysis, Determination of plastic zone, size and shape, Limitations ofLEFM.	09
2	**Surface Failures:** Friction: Rolling, Effect of roughness, velocity and lubrication on friction, Wear: Adhesive, Abrasive and Corrosive, Lubrication: Hydrodynamic, hydrostatic and elasto hydrodynamic lubrication, Surface Fatigue, Contact Stresses: Spherical, Cylindrical, General and Dynamic, Surface Fatigue Strength, design to avoid surface fatigue.	07
3	**Creep and Damping:** True stress and true strain, Creep phenomenon, Creep Curve, Creep parameters, time-temperature parameters and life estimate: Sherby- Dorn and Larson-Miller, Stress relaxation. Stress-Strain-Time relation, Creep deformation under varying stress, Component stress- strain analysis, Energy dissipation in materials.	07
4	**Fatigue Failure:** Fatigue test and stress life (S-N) approach, Factor Influences on S-N Behavior, Life Estimating using S-N curve, Fatigue from Variable Amplitude Loading, Spectrum Load and Cumulative Damage, Cumulative Damage Theories, Cycle Counting Methods, Life estimation using Stress Life Approach, Life Estimation using Strain Life Approach, Crack Growth and Life Estimation Model,	08
5	**Multiaxial stresses :** States of Stress and Strain and Proportional versus Non proportional Loading, Yielding and Plasticity in Multiaxial Fatigue , Stress-Based Criteria, Equivalent Stress Approaches, Sines Method, Examples Using the Stress-Life Approach , Strain-Based, Energy-Based, and Critical Plane Approaches, Strain-Based and Energy-Based Approaches, Critical Plane Approaches and the Fatemi-Socie Model, Example of Non proportional Loading, Fracture Mechanics Models for	08

	Fatigue Crack Growth, Notch Effects and Variable Amplitude Loading.	
6	**Housings :** The Function of Housings, Materials for Housings, Design of Housings , Housings Split through the Axes of Shafts, Design of Mounting Feet, Design of Lifting Elements, Housings Split at Right Angle to the Axes of the Shafts, Non-split Housings, Deformations and Stiffness Problems, Housing Seals, Sealing of Rigid Connections (Static Seals, Sealing Movable Joints ,Noncontact Seals, Contact Seals, Combined Seals.	06

Reference Books:

1. Mechanical Behaviourof Materials: Engineering Methods forDeformation Fracture an Fatigue 4\e N E DowlingPearson.
2. Machine Design: An Integrated Approach 3\e R L Norton,PearsonEducation.
3. Fundamentals of Machine Design 5\e R C Juvinall&K M Marshek,WileyIndia.
4. Mechanical Design of Machine Elements and Machines: A failure prevention perspective J ACollins, H Busby and G Stabb,WileyIndia.
5. Metal Fatigue in Engineering R I Stephens, A Fatemi, R RStephens and H O Fuchs,John-Wiley.
6. Elements of Fracture Mechanics,Prashant KumarMcGraw-Hill.
7. Engineering Design Dieter, GMcGraw-Hill
8. Machine Elements Life and Design, B M KleBanov, D M Barlam, F E Nystrom, CRC Press

Distribution of marks weightage for cognitive level

Bloom's Taxonomy for Cognitive Domain	Marks % weightage
Recall	10
Comprehension	10
Application	30
Analysis	40
Evaluate	10
Create	-

Course Outcome:

After learning the course the students will be able to:

Sr. No.	CO statement	Marks % weightage
CO-1	Make use of fracture mechanics, surface failure and creep in design of machine components.	35
CO-2	Demonstrate time dependent failure of machine components.	10
CO-3	Examine life of machine components based on fatigue failure.	30
CO-4	Construct the housing for gearboxes.	10
CO-5	Determine multiaxial stresses in machine components.	15

List of Experiments:

Students should be assigned work to design machine components/mechanisms and case studies which covers all topics mentioned in content. Examples:

1. Design of machine components subjected to fatigue loading, creep.
2. Design of mechanical components subjected to multiaxial stresses.
3. Failure analysis based on fracture mechanics.
4. Case study based on surface failure considerations, contact stresses for mating surfaces.

Major Equipment:

1. Computational facility and drawing hall facility.

GUJARAT TECHNOLOGICAL UNIVERSITY

Bachelor of Engineering
Subject Code: 3171926
Semester – VII
Subject Name: RAPID PROTOTYPING

Type of course: Professional Elective

Prerequisite: Nil

Rationale:
In present era it is highly essential to be able to prepare final product or its prototypes at the earliest. This is desirable to ensure that all the expected requirement of product are addressed and if required, its performance is also assessed from the prototype. Rapid prototyping offers a convenient option for manufacturing of product or its prototype from the CAD model

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks				Total Marks
L	T	P	C	Theory Marks		Practical Marks		
				ESE (E)	PA (M)	ESE (V)	PA (I)	
3	0	2	4	70	30	30	20	150

Content:

Sr. No.	Content	Total Hrs
1	Introduction: Introduction to Prototyping, Traditional Prototyping Vs. Rapid Prototyping (RP), Classification of Rapid Manufacturing Processes: Additive, Subtractive, Formative, Generic RP process.Distinction between RP and CNC, other related technologies.	04
2	CAD Modelling and Data Processing for RP: CAD model preparation, Data interfacing: formats (STL, SLC, CLI, RPI, LEAF, IGES, HP/GL, CT, STEP), conversation, validity checks, repair procedures; Part orientation and support generation, Support structure design, Model Slicing algorithms and contour data organization, direct and adaptive slicing, Tool path generation.	12
3	RP Processes: Process Physics, Tooling, Process Analysis, Material and technological aspects, Applications, limitations and comparison of various rapid manufacturing processes. Photopolymerization (Stereolithography (SL), Microstereolithography), Powder Bed Fusion (Selective laser Sintering (SLS), Electron Beam melting (EBM)), Extrusion-Based RP Systems (Fused Deposition Modelling (FDM)), 3D Printing, Sheet Lamination (Laminated Object Manufacturing (LOM), Ultrasonic Consolidation (UC)), Beam Deposition (Laser Engineered Net Shaping (LENS), Direct Metal Deposition (DMD)).	22
4	Errors in RP Processes: Pre-processing, processing, post-processing errors, Part building errors in SLA, SLS.	04
5	RP Applications: Design, Engineering Analysis and planning applications, Rapid Tooling, Reverse Engineering, Medical Applications of RP.	03

	Total Hours	**45**

Suggested Specification table with Marks (Theory):

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
15	**15**	**25**	**20**	**15**	**10**

Legends: R: Remembrance; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create and above Levels (Revised Bloom's Taxonomy)

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

Reference Books:

1. Chua C K, Leong K F, Chu S L, Rapid Prototyping: Principles and Applications in Manufacturing, World Scientific.

2. Gibson D W Rosen, Brent Stucker., Additive Manufacturing Technologies: Rapid Prototyping to Direct Digital Manufacturing, Springer.

3. Noorani R, Rapid Prototyping: Principles and Applications in Manufacturing, John Wiley & Sons.

4. Liou W L, Liou F W, Rapid Prototyping and Engineering applications: A tool box for prototype development, CRC Press.

5. Kamrani A K, Nasr E A, Rapid Prototyping: Theory and practice, Springer,

Course Outcomes:

Sr. No.	CO statement	Marks % weightage
CO-1	Distinguish RP and other related technology	10
CO-2	Understand and use techniques for processing of CAD models for rapid prototyping.	35
CO-3	Apply fundamentals of rapid prototyping techniques.	25
CO-4	Use appropriate tooling for rapid prototyping process.	20
CO-5	Create component with RP applications	10

List of Experiments:

Experiments based on above contents and should include below mentioned topics.

1) Review of CAD Modelling Techniques and Introduction to RP
2) Generating STL files from the CAD Models & Working on STL files
3) Processing the CAD data in Catalyst software (Selection of Orientation, Supports generation, Slicing, Tool path generation)
4) Fabricating the physical part on a RP machine
5) Prepare a CAD model with complex geometry and study effect of slicing parameters on final product manufactured through RP.

Design based Problems (DP)/Open Ended Problem: 1. Write codes to implement slicing algorithm. 2. Compare effect of slicing on quality of final product.

Major Equipment: 1. CAD Tools. 2. Rapid prototyping machine. 3. 3D Printer.

List of Open Source Software / Learning Website:
1. http://nptel.ac.in/syllabus/syllabus.php?subjectId=112104156

GUJARAT TECHNOLOGICAL UNIVERSITY

Bachelor of Engineering
Subject Code: 3171927
Semester –VII

Subject Name: Turbo machines

Type of course: Professional Elective

Prerequisite: Fluid Mechanics and Thermodynamics

Rationale: Turbines, compressors and fans are required to study as all turbo machines and their basic rotating components. The subject offers the thorough knowledge of fluid flow pattern, basic working principles and need of rotating element as per its requirement in all kind of turbo machines.

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks				Total Marks
				Theory Marks		Practical Marks		
L	T	P	C	ESE (E)	PA (M)	ESE (V)	PA (I)	
3	0	2	4	70	30	30	20	150

Content:

Suggested Specification table with Marks (Theory):

Sr. No.	Content	Total Hrs
1	**Introduction to Turbomachineries**: turbines, pumps and compressors, fans and blowers, compressible flow machines, incompressible flow machines Energy transfer between fluid and rotor-classification of fluid machinery,-dimensionless parameters-specific speed-applications-stage velocity triangles-work and efficiency.	07
2	**Axial Flow Turbines**: Introduction, Stage velocity triangle, Single impulse stage, Multistage velocity compounded impulse and Multistage pressure compounded impulse, Reaction stages, Blade to gas speed ratio, Losses and efficiencies, Performance charts, Low hub-tip ration stage. **Radial Flow Turbines**: Elements of radial turbine stage, Stage velocity triangles, H-S diagram, Stage losses, Outward flow radial stage and Performance characteristics.	12
3	**Axial Flow Compressor:** Introduction. Geometry and working principle, Stage velocity triangles, H-S diagram. Flow through blade row, Stage losses and efficiency, Work done factor, Low hub-tip ratio, Supersonic and transonic stages, Performance characteristics	08
4	**Centrifugal Compressor:** Introduction and different parts of centrifugal compressor, Principles of operation. H-S diagram. Nature of impeller flow, Slip factor, Diffuser, Volute casing, Performance characteristics and losses in centrifugal compressor.	08
5	**Fans and Blowers**: Fan and Blowers types-stage and design parameters-flow analysis in impeller blades-volute and diffusers, losses, characteristic curves and selection, drives and noise. Noise problems in fans and Blowers	07

6	Use of CFD for Turbo machineries analysis and design.	03

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
20	**20**	**40**	**20**	**0**	**0**

Legends: R: Remembrance; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create and above Levels (Revised Bloom's Taxonomy)

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

Course Outcomes:

Sr. No.	CO statement	Marks % weightage
CO-1	Understand to apply physics of flow through turbomachines.	15
CO-2	Understand the analysis of radial and axial flow turbines, its losses and performance	35
CO-3	Understand the analysis of centrifugal and axial flow compressors, its losses and performance	35
CO-4	Understand the fan and blowers machines their need and it's applications	15

List of Experiments:

1. Study or performance of axial flow turbines performance and its efficiency.
2. Study or performance of Radial flow turbines performance and its efficiency.
3. Study or performance of axial flow Compressors performance and its efficiency.
4. Study or performance of centrifugal compressors performance and its efficiency.
5. Performance study of axial fan
6. Study of centrifugal air blower

Reference Books:

1. An Introduction to Energy Conversion, Volume III, Turbo machinery, V. Kadambi and Manohar Prasad, New Age International Publishers, reprint 2008.
2. Turbines, Compressors & Fans, S. M. Yahya, Tata McGraw Hill Co. Ltd., latest edition.
3.
4. Principals of Turbomachines, D. G. Shepherd, The Macmillan Company (1964)
5. Fluid Mechanics & Thermodynamics of Turbomachines, S. L. Dixon, Elsevier (2005)
6. Text Book of Turbomachines, M. S. Govindgouda and A. M. Nagaraj, M. M. Publications, 4Th Ed, 2008
7. Turbomachine, B.K.Venkanna PHI, New Delhi 2009

.

List of Open Source Software/learning website:
https://nptel.ac.in/courses/101/101/101101058/

Major Equipment: Apparatus for Axial and Radial Turbines, Axial fan apparatus, Test rig for Centrifugal compressor and computer systems for CFD

GUJARAT TECHNOLOGICAL UNIVERSITY

Bachelor of Engineering
Subject Code: 3171928
Design of Material Handling Equipment
B.E. 7thSEMESTER

Type of course: Professional Core

Prerequisite: None**.**

Rationale: The course aims to impart basic skills of force and stress analysis for design of machine elements.

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks				Total Marks
				Theory Marks		Practical Marks		
L	T	P	C	ESE (E)	PA (M)	ESE (V)	PA (I)	
3	0	2	4	70	30	30	20	150

Content:

Sr. No.	Content	Total Hrs
1	**Introduction:** Objectives of material handling system, Principal groups of materials handling equipment and classification, Scope of Material Handling, Criteria for selection of Material Handling Equipment's, Basic kind of material handling problems, Various methods to analyze material Handling problems.	06
2	**Conveyor Design:** Introduction to Apron conveyors , Pneumatic conveyors, Belt Conveyors, Chain conveyors, Screw conveyors and vibratory conveyors and their applications, Design of Belt conveyor- Belt selection procedure and calculation of drop energy, Idler design.	10
3	**Design of bucket and Cage Elevator:** Introduction, Types of Bucket Elevator, Design of Bucket Elevator- loading and bucket arrangements, Cage elevators, shaft way, guides, counter weights.	05
4	**Design of Hoists:** Design of hoisting elements: Welded and roller chains – Hemp and wire ropes - Design of ropes, pulleys, pulley systems, sprockets and drums, Load handling attachments. Design of forged hooks and eye hooks – crane grabs - lifting magnets - Grabbing attachments - Design of arresting gear -Brakes: shoe, band and cone types.	10
5	**Design of Cranes:** Hand-propelled and electrically driven overhead traveling cranes; Traveling mechanisms of cantilever and monorail cranes , goliath cranes; design considerations for structures of rotary cranes with fixed radius ; fixed post and overhead traveling cranes; Stability of stationary rotary and traveling rotary cranes.	10
6	**Packaging and storage of bulk materials**: Steps for design of packages, protective packaging, testing the physical characteristics of packaging, container testing, types of storage and industrial containers, Automatic guided vehicles, Automatic storage and retrieval system.	04

Reference Books:

1. Belt conveyors for bulk materials Conveyor Equipment Manufacturer's Association, 6th edition, The New CEMA Book.
2. Materials handling equipment, Rudenko N., Elnvee Publishers.
3. Material Handling Handbook, Raymond A Kulwiec, John Wiley & Sons.
4. Engineering Science and application design for belt conveyor , Ishwar G Mulani and Mrs. Madhu I Mulani, Madhu I. Mulani.
5. Materials Handling Equipments, Alexandrov, M, MIR Publishers.
6. Bulk Materials Handling Handbook, Jacob Fruchtbaum, Springer Science +Business Media

Distribution of marks weightage for cognitive level

Bloom's Taxonomy for Cognitive Domain	Marks % weightage
Recall	10
Comprehension	10
Application	30
Analysis	40
Evaluate	10
Create	-

Course Outcome:

After learning the course the students will be able to:

Sr. No.	CO statement	Marks % weightage
CO-1	Compare and select material handling equipment for material transportation.	15
CO-2	Construct the conveyors for handling bulk materials.	35
CO-3	Analyze elements of hoisting mechanisms used in industry for material handling,	35
CO-4	Examine packaging and storage systems used in industry.	15

List of Experiments:

Computation and drawing work related to design of belt conveyor, hoisting mechanism, cranes and packaging systems.

Major Equipment:

1. Computational facility.

List of Open Source Software/learning website: http://nptel.ac.in

GUJARAT TECHNOLOGICAL UNIVERSITY

Bachelor of Engineering
Subject Code: 3171929
Semester –VII
Subject Name: Quality and Reliability Engineering

Type of course: NA

Prerequisite: Nil

Rationale:

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks				Total Marks
				Theory Marks		Practical Marks		
L	T	P	C	ESE (E)	PA (M)	ESE (V)	PA (I)	
3	0	2	4	70	30	30	20	150

Content:

Sr. No.	Content	Total Hrs
1	**Introduction to Quality:** Concept, Different Definitions and Dimensions, Inspection, Quality Control, Quality Assurance and Quality Management, Quality as Wining Strategy, Views of different Quality Gurus.	04
2	**Total Quality Management (TQM):** Introduction, Definitions and Principles of Operation, Tools and Techniques, such as, Quality Circles, 5 S Practice, Total Quality Control (TQC), Total Employee Involvement (TEI), Problem Solving Process, Quality Function Deployment (QFD), Failure Mode and Effect analysis (FMEA), Fault Tree Analysis (FTA), Kizen, Poka-Yoke, 7QC Tools, PDCA Cycle, 7 New Quality Improvement Tools, TQM Implementation and Limitations.	08
3	**Introduction to Design of Experiments:** Introduction, Methods, Taguchi approach, Achieving robust design, Steps in experimental design.	07
4	**Just –in –Time, Quality Management, Total Productive Maintenance (TPM) and ISO:** Introduction to JIT production system, KANBAN system, JIT and Quality Production, TPM: Content, Methods and Advantages ISO 9000, ISO 14000 and QS 9000: Basic Concepts, Scope, Implementation, Benefits, Implantation Barriers.	08
7	**Contemporary Trends:** Concurrent Engineering, Lean Manufacturing, Agile Manufacturing, World Class Manufacturing, Cost of Quality (COQ) system, Bench Marking, Business Process Re-engineering, Six Sigma: Basic Concept, Principle, Methodology, Implementation, Scope, Advantages and Limitation of all as applicable.	09
8	**Reliability:** Introduction, Concepts of Reliability and failure: Reliability, Failure, Failure mechanism,	10

	failure severity and consequences. Reliability basic functions: Probability density function, cumulative function and reliability function, conditional distribution and residual life, failure rate and cumulative hazard functions, relation between reliability basic functions. Life characteristics: Measure of life time, Dispersion of lifetime, Skewness and kurtosis of life dispersion. Reliability of repairable system: Failure repair process, Reliability measure, Reliability point process. Evolution of reliability over Product life cycle: Design reliability, Inherent reliability, Reliability at sale, field reliability.	
	Total Hours	**45**

Suggested Specification table with Marks (Theory): (For BE only)

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
10	15	25	20	15	15

Legends: R: Remembrance; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create and above Levels (Revised Bloom's Taxonomy)

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

Reference Books:

1. Quality Control & Application by B. L. Hanson & P. M. Ghare, Prentice Hall of India
2. Introduction to Quality and Reliability Engineering, Jiang R, Springer Publication, 2015.
3. Quality Assurance and Total Quality Management (ISO 9000, QS 9000 ISO 14000) by K C Jain and A K Chitale, Khanna Publishers
4. Total Quality Management by Dale H. Besterfield, Carol Besterfield-Michna, Glen H. Besterfield and Mary Besterfield-Sacre, Pearson Educaiton
5. Total Quality Management – Dr. S. Kumar, Laxmi Publication Pvt. Ltd.
6. Reliability Engineering by Srinath L. S., Affiliated East West Press.
7. Total Quality Management by K C Arora, S K Kataria & Sons
8. Total Quality Management: Poornima M. Charantimath, Pearson education(Singapore) Pte. Ltd.
9. Managing for Total Quality: N. Logothetis, Prentice Hall of India Pvt. Ltd.
10. Managing Quality : Barrie G. Dole, Blackwell publishing
11. TQM – an integrated approach – Samunel K Ho, Crest pubslishing House.

Course Outcomes: Students will be able to:

Sr. No.	CO statement	Marks % weightage
CO-1	Interpret Quality and Total quality management	30
CO-2	Make use of design of experiments, concepts of just in time and quality management.	25
CO-3	Illustrate Total Productive maintenance and ISO.	20

CO-4	Utilize knowledge of contemporary trends in quality engineering and Reliability Engineering in industry.	25

Term Work:
The term work shall be based on the topics mentioned above.

GUJARAT TECHNOLOGICAL UNIVERSITY

Bachelor of Engineering
Subject Code: 3171930

Semester – VII
Subject Name: Industrial Internet of Things

Type of course: Professional Elective

Prerequisite: Nil

Rationale:
IoT will change industries and transform the way we work and live. Industrial companies are already pivoting from Products to Services leveraging IoT technologies – this digital transformation is more broadly called the Industrial IoT or Industrial Internet. The objective of this subject is make students aware about this latest technology, its application and to identify future scope for better manufacturing system.

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks				Total Marks
				Theory Marks		Practical Marks		
L	T	P	C	ESE (E)	PA (M)	ESE (V)	PA (I)	
03	0	00	03	70	30	0	0	100

Content:

Sr. No.	Content	Total Hrs
1	**Understanding Industrial Internet of Things (IIoT):** Industrial Internet of Things and Cyber Manufacturing Systems, Application map for Industrial Cyber Physical Systems, Cyber Physical Electronics production.	08
2	**Modeling of CPS and CMS:** Modeling of Cyber Physical Engineering and manufacturing, Model based engineering of supervisory controllers for cyber physical systems, formal verification of system, components, Evaluation model for assessments of cyber physical production systems.	10
3	**Architectural Design Patterns for CMS and IIoT:** CPS-based manufacturing and Industries 4.0., Integration of Knowledge base data base and machine vision, Interoperability in Smart Automation, Enhancing Resiliency in Production Facilities through CPS. Communication and Networking of IIoT.	08
4	**Artificial Intelligence and Data Analytics for manufacturing:** Application of CPS in Machine tools, Digital production, Cyber Physical system Intelligence, Introduction to big data and machine learning and condition Monitoring.	06

5	**Evaluation of Workforce and Human Machine Interaction:** Worker and CPS, Strategies to support user intervention. Introduction to Advance manufacturing and Innovation Ecosystems.	**06**
6	**Application of IIoT:** Smart Metering, e-Health Body Area Networks, City Automation, Automotive Applications, Home Automation, Smart Cards, Plant Automation, Real life examples of IIOT in Manufacturing Sector.	**07**

Suggested Specification table with Marks (Theory):

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
20	**30**	**30**	**20**	**0**	**0**

Legends: R: Remembrance; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create and above Levels (Revised Bloom's Taxonomy)

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

Reference Books:

1. Sabina Jeschke, Christian Brecher Houbing Song , Danda B. Rawat Editors Industrial Internet of Things Cyber Manufacturing Systems
2. Hakima Chaouchi, " The Internet of Things Connecting Objects to the Web" ISBN : 978-1- 84821-140-7, Willy Publications Olivier Hersent, David Boswarthick, Omar Elloumi,
3. The Internet of Things: Key Applications and Protocols, ISBN: 978-1-119-99435-0, 2nd Edition, Willy Publications
4. Inside the Internet of Things (IoT), Deloitte University Press
5. Internet of Things- From Research and Innovation to Market Deployment; By Ovidiu & Peter; River Publishers Series
6. Five thoughts from the Father of the Internet of Things; by Phil Wainewright - Kevin Ashton
7. How Protocol Conversion Addresses IIoT Challenges: White Paper By RedLion.
8. Dr. Guillaume Girardin , Antoine Bonnabel, Dr. Eric Mounier, 'Technologies Sensors for the Internet of Things Businesses & Market Trends 2014 -2024',Yole Development Copyrights ,2014

Course Outcomes:

Sr. No.	CO statement	Marks % weightage
CO-1	Describe Industrial Internet of Things and Cyber Physical manufacturing	15
CO-2	Demonstrate Cyber Physical and Cyber Manufacturing systems	20

CO-3	Describe Architectural design patterns for industrial Internet of Things	20
CO-4	Analyse AI and data Analytics for Industrial Internet of Things	20
CO-5	Evaluation of Workforce and Human Machine Interaction and Application of Industrial Internet of Things	25

GUJARAT TECHNOLOGICAL UNIVERSITY

Bachelor of Engineering
Subject Code: 3171931
Semester –VII
Subject Name: Nanotechnology and Surface Engineering

Type of course: Open Elective

Prerequisite: Zeal to learn the subject

Rationale:

To make students understand the use of concept of nanotechnology and nanoscience in the industries and in consumer products. The surface properties must be modified for aesthetics, oxidation resistance, hardness, wear resistance, fatigue resistance or other considerations. This course will be useful for the student to develop essential skill & knowledge of the surface coating technologies in demand.

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks				Total Marks
				Theory Marks		Practical Marks		
L	T	P	C	ESE (E)	PA (M)	ESE (V)	PA (I)	
3	0	0	3	70	30	00	0	100

Content:

Sr. No.	Content	Total Hrs
1	**Basic Elements of Nano-science and Nanotechnology:** Engineering scale of nanotechnology, different classes of nano-materials, synthesis of nano-materials, fabrication and characterization of nanostructures, Engineering applications- Cosmetics and Consumer Goods, Nano Sensor, Nano catalysts, Water Treatment and the Environment, Paints, Food and Agriculture Industry.	12
2	**Nanotechnology and Ceramics :** Introduction, Vapor Condensation Methods, Sputtering, Laser Method, Spray Pyrolysis, Thermo Chemical /Flame Decomposition of metal organic Precursors methods	8
3	**Tools to characterize Nanomaterials:** X-Ray Diffraction (XRD), Scanning Electron Microscopy (SEM), Transmission Electron Microscopy (TEM), Atomic Force Microscopy,UV/Visible Spectroscopy	6
4	**Surface Engineering:** Introduction to surface engineering, Scope of surface engineering for different engineering materials, Surface Preparation methods such as Chemical, Electrochemical, Mechanical: Sand Blasting, Shot peening, Shot blasting, Hydro-blasting, Vapor Phase Degreasing etc., Coatings: Classification, Properties and applications of Various Coatings.	6
5	**Different methods for surface modifications:** Surface modification by use of directed energy beams, Plasma, Sputtering & Ion Implantation. Surface modification by Friction stir processing. Surface composites.	**10**
6	Case studies based on coatings and surface modification of important engineering components.	**5**

Suggested Specification table with Marks (Theory):

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
20	**20**	**40**	**20**	**-**	**-**

Legends: R: Remembrance; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create and above Levels (Revised Bloom's Taxonomy)

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

Reference Books:

1. Nanostructures and Nanomaterials: Synthesis, Properties and Applications by G. Cao, Imperial College Press, 2004.
2. Nanoscale Science and technology by Robert Kelsall (editor), Ian W. Hamley (co-editor), Mark Geoghegan (co-editor) , ISBN: 978-0-470-85086-2
3. The Chemistry of Nanomaterials: Synthesis, Properties and Applications by C. N. R. Rao, A. Muller, A. K. Cheetham, WILEY-VCH Verlag GmbH & Co. KGaA, Weinheim, ISBN: 3-527-30686-2.
4. Nanoscale Materials in Chemistry Edited by Kenneth J. Klabunde, John Wiley & Sons, Inc., ISBNs: 0-471-38395-3 (Hardback); 0-471-22062-0.
5. Textbook of Nanoscience and Nanotechnology, B.S. Muty, P. Shankar, Baldev Raj, B.B Rath and James Murday, University Press, IIM (ISBN-978 81 7371 738 3).
6. Introduction to Nanotechnology by Charles P. Poole Jr and. Frank J. Owens, Wiley-Inter science, 2003.
7. James A. Murphy- Surface Preparation and Finishes for Metal, McGraw-Hill, New York 1971
8. Surface Engineering Hand Book, edited by Keith Austin, London : Kogan Page, 1998

Course Outcomes:

Sr. No.	CO statement	Marks % weightage
CO-1	To comprehend basics of nano-science and technology and their applications in the domain of engineering.	20
CO-2	To impart fundamental knowledge of various methods used in the field of nano-technology	20
CO-3	To impart basics of various characterization tools/methods in the field of Nano-Technology.	20
CO-4	Explain the effect of process parameters on the properties & microstructure of the surface coating processes.	20
CO-5	Understand the importance & role of surface modifications to achieve several technological properties.	20

List of Experiments:

Major Equipment: Electronics Microscope, XRD, UV

List of Open Source Software/learning website: https://nptel.ac.in/course.php