



GUJARAT TECHNOLOGICAL UNIVERSITY

Bachelor of Engineering

Subject code: 3160002

Contributor Personality Development Program

SEMESTER VI

Type of course: Work-Personality Development

For Year: Pre-final year for all Diploma, Degree & Masters programmes over 2 semesters. For e.g. for Bachelors of Pharmacy and Engineering, the course will be conducted in Semesters V & VI.

Rationale: The Contributor Program aims to accomplish the following outcomes in the lives of students–

- Improve the employability of students by giving them the right work ethic and thinking that employers are looking for.
- Build their confidence with which they can go into any job and contribute meaningfully.
- Improve their ability to engage better in the workplace and to be able to handle the challenges that come up there.
- Build their career-worthiness and help them develop into future-ready contributors with ability to navigate a career in a volatile, changing world.
- Widen their choices of career and success, so that they are able to open up more opportunities for themselves and take up unconventional career pathways.
- Enable them to recognize how they, as technical professionals, can participate and make a positive contribution to their communities and to their state.

Towards this goal, the Contributor Program has been designed to awaken and strengthen students from within, in terms of building positive self-esteem, increasing their confidence level and I-can attitude, improving their aspirations, giving them new methods of thinking, building their cognitive capacities, exposing them to the skills and practices associated with being contributors in the workplace (not mere employees).

The Program content is also designed to expose students to real-world workplace scenarios and sensitize them to some of the challenges faced in society around them, especially in the local communities around them and in their own state of Gujarat.

The Contributor Program syllabus has been evolved and fine-tuned over several years, (a) to address the changing need and contemporary challenges being faced by industry and what employers of today are looking for in the people they hire and (b) by working extensively with universities and students building an appreciation of their challenges and concerns. At the core, the program is guided by the higher ideas and principles of practical Vedanta in work.

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

COURSE CONTENT :

Sr. No.	Content	Total Hrs
1	Finding Solutions The market environment in which organizations are operating, is becoming increasingly dynamic and uncertain. So, employers are increasingly seeking out people who can innovate and figure out solutions in the face of any challenge (unlike in the past when it was the	1.5 hrs Classroom engagement (including self-discovery/ solutioning sessions)



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	<p>people who were most efficient and productive, who were valued by organizations). At the heart of innovation lies this way of thinking of “finding solutions” rather than “seeing problems or roadblocks”.</p> <p>Students learn how to build this way of thinking, in this topic.</p>	
2	<p>Creating Value</p> <p>Companies are also looking for employees who do not just work hard, or work efficiently or productively - but those who will make a valuable difference to the fortunes of the company. This difference may come from innovation, but it may also come from focusing on the right things and identifying what really matters – both to the company and to the customers. In this topic, students learn how to build this capability.</p>	Same as above
3	<p>Engaging deeply</p> <p>The environment we live in is becoming increasingly complex because more and more things are getting interconnected, new fields are emerging, technologies are rapidly changing, capabilities and knowledge one is trained in will become fast obsolete. In such a scenario, the student’s ability to quickly understand and master what is going on, dive deep, get involved in any area, rapidly learn new capabilities that a job demands, is important. Engaging deeply is a core way of thinking that can help them in this. In this topic, students learn how to engage deeply.</p>	Same as above
4	<p>Enlightened self-interest & collaboration at work</p> <p>The changing nature of work in organizations and in the global environment is increasingly demanding that people work more collaboratively towards shared goals and more sustainable goals. A key to working successfully when multiple stakeholders are involved is “thinking in enlightened self-interest”. In this topic, students learn how to develop this way of thinking (going beyond “narrow self-interest”).</p>	Same as above
5	<p>Human-centered thinking & Empathy</p> <p>In this topic, students explore a human-centric approach to work – where the ability to recognize and respond to other people (whether they are users or customers or team members) as a human being with human needs and difficulties, is essential. This is at the heart of user-centric design of products and solutions, at the heart of genuine customer-centricity in services, and of any successful interaction with other people.</p>	Same as above
6	<p>Trust Conduct</p> <p>The biggest currency in a sustainable career is “trust” i.e. being trusted by team members, bosses, and customers. When we are trusted, people listen to us, they are willing to give us the chance to grow, give us the space to make mistakes, and work seamlessly with each other without always having to “prove ourselves”. In this topic, students learn how to demonstrate conduct that builds the trust of people.</p>	Same as above
Showcase Lab Sessions		3 hrs
Project work		Beyond classroom



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Distribution of Theory Marks

R Level	U Level	A Level	N Level	E Level	C Level
-	15	15	-	20	20

Reference resources:

A. Basic reference for both students and teachers

1. Contributor Personality Program textbook cum workbook developed by Illumine
2. Web-based ActivGuide™ for self-exploration of rich media resources to vividly understand many of the ideas, watch role models, learn from industry people, get reference readings – that help them enrich the understanding they gained in the class published by Illumine Foundation

B. Advanced reference for teachers

1. On Contributors, Srinivas V.; Illumine Ideas, 2011
2. Enlightened Citizenship and Democracy; Swami Ranganathananda, Bharatiya Vidya Bhavan, 1989
3. Eternal Values for a Changing Society – Vol I-IV, Swami Ranganathananda; Bharatiya Vidya Bhavan
4. Karma Yoga, Swami Vivekananda; Advaita Ashrama
5. Vivekananda: His Call to the Nation, Swami Vivekananda; Advaita Ashrama
6. Six Pillars of Self Esteem, Nathaniel Branden; Bantam, 1995
7. Mindset: The New Psychology of Success, Carol S. Dweck; Random House Publishing Group, 2007
8. Lasting Contribution: How to Think, Plan, and Act to Accomplish Meaningful Work, Tad Waddington; Agate Publishing, 2007
9. Why not?: how to use everyday ingenuity to solve problems big and small, Barry Nalebuff, Ian Ayres; Harvard Business School Press, 2003
10. The value mindset: returning to the first principles of capitalist enterprise (Ch 8 & 9); Erik Stern, Mike Hutchinson; John Wiley and Sons, 2004
11. The Power of Full Engagement: Managing Energy, Not Time, is the Key to High Performance and Personal Renewal, Jim Loehr, Tony Schwartz; Simon and Schuster, 2003
12. Creating Shared Value, Michael E. Porter and Mark R. Kramer; Harvard Business Review; Jan/Feb2011, Vol. 89 Issue 1/2
13. The Speed of Trust: The One Thing That Changes Everything, Stephen M. R. Covey, Rebecca R. Merrill, Stephen R. Covey; Free Press, 2008
14. The Courage to Meet the Demands of Reality, Henry Cloud; HarperCollins, 2009
15. Responsibility at work: how leading professionals act (or don't act) responsibly, Howard Gardner; John Wiley & Sons, 2007



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Course Outcomes:

Sr. No.	CO statement	Marks % weightage
Outcome of theory sessions		
CO-1	Students will be able to recognize & appreciate the thinking required to find solutions in the face of any challenge.	10-12%
CO-2	Students will be able to recognize & appreciate different types of value that can be created and the different ways to create value for others.	10-12%
CO-3	Students will be able to recognize & appreciate how to engage deeply, and its need, value, payoffs and consequences in different contexts.	10-12%
CO-4	Students will be able to differentiate between 'enlightened self-interest' and 'narrow self-interest' & appreciate the payoffs/ consequences of both when working with multiple stakeholders.	10-12%
CO-5	Students will be able to recognize & appreciate the human side of situations or interactions or projects that will help them develop a more human-centric approach/ response to work.	10-12%
CO-6	Students will be able to recognize & appreciate conduct which builds trust of people in contrast to conduct which breaks trust of people - in teams / organization & the value of trust conduct in various situations.	10-12%
Outcome of practical sessions		
CO-7	Students complete their 'Contributor Showcase Profile' on the Showcase Platform. This includes (a) completing Illumine's Contributor Mindset Assessment (b) building evidence to demonstrate their functional orientations as contributors.	15%
CO-8	Students learn to apply contributor thinking to think-through and address real-world challenges.	15%



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INTEGRATED PERSONALITY DEVELOPMENT COURSE

SEMESTER VI

TYPE OF COURSE –

- Value-based holistic personality development course for university students.

RATIONALE -

- This course aims to help a person understand and know his / her purpose in life, get a positive thought pattern, gain confidence, improve behaviour, learn better communication and develop a healthy physique with morality and ethics in its core.
- Today's youth lack the guidance to face insecurity about their health and career, premature relationships and family breakdown, addictions and substance abuse, negative impact of internet and social media etc. This course includes such topics that will cover all aspects and provide solution to the current challenges through creative and interactive activities.
- This course will allow students to enjoy, understand and practice invaluable lessons preparing them for a successful future.

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

COURSE CONTENT :

Lecture No.	Content	Hours
1	Facing Failures - Insignificance of Failures	2
2	Facing Failures - Power of Faith	2
3	Facing Failures - Practicing Faith	2
4	From House to Home - Bonding the Family	2
5	Learning from Legends - Leading without Leading (Pramukh Swami Maharaj)	2
6	Review Lecture – Words of Wisdom	2
7	My India My Pride - Glorious Past - Part 1	2
8	My India My Pride - Glorious Past - Part 2	2



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9	My India My Pride - Present Scenario	2
10	Remaking Yourself - Begin with the End in Mind	2
11	My India My Pride - An Ideal Citizen - 1 (Accountability - Responsibility - Honesty - Integrity)	2
12	My India My Pride - An Ideal Citizen - 2 (Loyalty - Sincerity - Punctuality)	2
13	My India My Pride - An Ideal Citizen - 3 (Ethical & Moral Values/Practices)	2
14	Financial Wisdom - Financial Planning Process	2
15	Review Lecture - Student Voice-2	2

BASIC STUDY MATERIAL / MAIN COURSE WORK-BOOK -

1. IPDC Workbook-I
2. IPDC Workbook-II

IPDC REFERENCES –

- *These are the reference material for each lectures of IPDC.*

Module No.	Module/ Course Topics	Lectures	References
1	Facing Failures	Factors Affecting Failures Failures are not Always Bad Insignificance of Failures Power of Faith Practicing Faith	<ol style="list-style-type: none">1. Thomas Edison's factory burns down, New York Times Archives, Page 1, 10/12/19142. Lincoln Financial Foundation, Abraham Lincoln's "Failures": Critiques, Forgotten Books, 20173. J.K. Rowling Harvard Commencement Speech Harvard University Commencement, 20084. Born Again on the Mountain: A Story of Losing Everything and Finding It Back, Arunima Sinha, Penguin, 20145. Failing Forward: Turning Mistakes Into Stepping Stones for Success, John C. Maxwell, Thomas Nelson, 20076. Steve Jobs: The Exclusive Biography Paperback, Walter Isaacson, Abacus, 2015



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2	Learning from Legends	Tendulkar & Tata Leading Without Leading	<ol style="list-style-type: none"> 1. Chase Your Dreams: My Autobiography, Sachin Tendulkar, Hachette India, 2017 2. Playing It My Way: My Autobiography, Sachin Tendulkar, Hodder & Stoughton, 2014 3. The Wit and Wisdom of Ratan Tata, Ratan Tata, Hay House, 2018 4. The Tata Group: From Torchbearers to Trailblazers, Shashank Shah, Penguin Portfolio, 2018 5. The Leader Who Had No Title, Robin Sharma, Jaico Publishing House, 2010 6. In the Joy of Others: A Life Sketch of Pramukh Swami Maharaj, Mohanlal Patel and BAPS Sadhus, Swaminarayan Aksharpath, 2013
3	Mass Management	Project Management	<ol style="list-style-type: none"> 1. Project Management Absolute Beginner's Guide, Gregory Horine, Que Publishing, 2017 2. The Fast Forward MBA in Project Management, Eric Verzuh, Wiley, 2011 3. Guide to Project Management: Getting it right and achieving lasting benefit, Paul Roberts, Wiley, 2013
4	My India My Pride	Glorious Past - Part 1 Glorious Past - Part 2 Present Scenario An Ideal Citizen - 1 An Ideal Citizen - 2 An Ideal Citizen - 3	<ol style="list-style-type: none"> 1. Hidden Horizons, Dr. David Frawley and Dr. Navaratna S. Rajaram, 2006 2. Rishis, Mystics and Heroes of India, Sadhu Mukundcharandas, Swaminarayan Aksharpath, 2011 3. Physics in Ancient India, Narayan Dongre, Shankar Nene, National Book Trust, 2016 4. <u>The Rise of Civilization in India and Pakistan</u>, Raymond Allchin, Bridget Allchin, <u>Cambridge University Press</u>, 1982 5. The Āryabhaṭīya of Āryabhaṭa: An Ancient Indian Work on Mathematics and Astronomy (1930), Walter Eugene Clark, University of Chicago Press, reprint, Kessinger Publishing, 2006
5	Remaking Yourself	Restructuring Yourself Power of Habit Being Addiction-Free Begin with the End in Mind Handling the Devil – Social Media	<ol style="list-style-type: none"> 1. Power of Habit, Charles Duhigg, Random House Trade Paperbacks, 2014 2. Change Your Habit, Change Your Life, Tom Corley, North Loop Books, 2016 3. The Seven Habits of Highly Effective People, Stephen Covey, Simon & Schuster, 2013 4. Seven Habits of Highly Effective Teens, Sean Covey, Simon & Schuster, 2012 5. Atomic Habits, James Clear, Random House, 2018 6. How a handful of tech companies control billions of minds every day, Tristan Harris, TED Talk, 2017



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6	Financial Wisdom	Basics of Financial Planning Financial Planning Process	<ol style="list-style-type: none">1. Rich Dad Poor Dad, Robert Kiyosaki, Plata Publishing, 20172. The Warren Buffett Way, Robert Hagstrom, Wiley, 20133. The Intelligent Investor, Benjamin Graham, Harper Business, 20064. Yogic Wealth: The Wealth That Gives Bliss, Gaurav Mashruwala, TV18 Broadcast Ltd, 2016
7	From House to Home	Affectionate Relationships Forgive & Forget Listening & Understanding Bonding the Family	<ol style="list-style-type: none">1. “What Makes a Good Life? Lessons from the Longest Study on Happiness”, R. Waldinger, Ted Talks, 20152. Long Walk To Freedom, Nelson Mandela, Back Bay Books, 19953. Outliers, Malcolm Gladwell, Back Bay Books, 2011
8	Soft Skills	Teamwork & Harmony Networking - Decision Making - Leadership	<ol style="list-style-type: none">1. The 17 Indisputable Laws of Teamwork, John Maxwell, HarperCollins, 20132. Team of Teams: New Rules of Engagement for a Complex World, Stanley McChrystal, Portfolio, 20153. Predictably Irrational, Revised and Expanded Edition: The Hidden Forces That Shape Our Decisions, Harper Perennial, Dan Ariely, 2010
9	Review	Student Voice – 1 Student Voice – 2 Words of Wim	

COURSE OUTCOMES –

- To provide students with a holistic education – focused on increasing their intelligence quotient, physical quotient, emotional quotient and spiritual quotient.
- To provide students with hard and soft skills, making them more marketable when entering the workforce.
- To educate students on their social responsibilities as citizens of India and have a greater sense of social responsibility.
- To provide students with a value-based education which will enable them to be successful in their family, professional, and social relationships by improving their moral and ethical values.
- To teach self-analysis and self-improvement exercises to enhance the potential of the participants.
- To have a broader sense of self-confidence and a defined identity.



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Semester –VI

Subject Name: Computer Aided Design

Type of Course: Elective

Prerequisite: Nil

Rationale:

Computers have become inevitable in today era and find their application in various stages of product development. This course intends to introduce students to use of computers in the phases of product design viz. conceptualization, geometric modeling, graphical representation and finite element analysis.

Teaching and Examination Scheme:

Teaching Scheme			Credits C	Examination Marks				Total Marks
L	T	P		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 Hours
1	Introduction: A typical product cycle, CAD tools for the design process of product cycle, CAD / CAM system evaluation criteria, Input / Output devices; Graphics Displays: Refresh display, DVST, Raster display, pixel value and lookup table, estimation of graphical memory, LCD, LED fundamentals. Concept of Coordinate Systems: Working Coordinate System, Model Coordinate System, Screen Coordinate System. Line and Curve generation algorithm: DDA, Bresenham's algorithms. Graphics exchange standards and Database management systems.	05
2	Curves and Surfaces: Parametric representation of lines: Locating a point on a line, parallel lines, perpendicular lines, distance of a point, Intersection of lines. Parametric representation of circle, Ellipse, parabola and hyperbola. Synthetic Curves: Concept of continuity, Cubic Spline: equation, properties and blending. Bezier Curve: equations, properties; Properties and advantages of B-Splines and NURBS. Various types of surfaces along with their typical applications.	07
3	Mathematical representation of solids: Geometry and Topology, Comparison of wireframe, surface and solid models, Properties of solid model, properties of representation schemes, Concept of Half-spaces, Boolean operations. Schemes: B-rep, CSG, Sweep representation, ASM, Primitive instancing, Cell Decomposition and Octree encoding.	04



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4	Geometric Transformations: Homogeneous representation; Translation, Scaling, Reflection, Rotation, Shearing in 2D and 3D; Orthographic and perspective projections. Window to View-port transformation.	05
5	Finite Element Analysis: Review of stress-strain relation and generalized Hooke's Law, Plane stress and Plane strain conditions; Concept of Total Potential Energy; Basic procedure for solving a problem using Finite Element Analysis. 1-D Analysis: Concept of Shape function and natural coordinates, strain - displacement matrix, derivation of stiffness matrix for structural problems, properties of stiffness matrix. 1-D structural problems with elimination and penalty approaches, 1-D thermal and fluid problems. Trusses and Beams: Formulation of stiffness matrix, simple truss problems to find displacement, reaction and stresses in truss members. Structural analysis using Euler-Bernoulli beam element.	18
6	Engineering optimization: Introduction to optimization techniques design of Machine Elements, Johnson's method.	04

Suggested Specification table with %Marks (Theory):

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

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

Course Outcomes: Students will be able to:

Sr. No.	CO statement	Marks % weightage
CO-1	Demonstrate basic concept of computer aided design and its applications.	20
CO-2	Make use of various concepts and characteristics in geometric modeling.	20
CO-3	Analyze geometric transformations.	25
CO-4	Determine stress and strain in structural elements through FEA.	25
CO-5	Summarized optimization techniques for design of machine elements.	10

Reference Books:

1. Ibrahim Zied, CAD / CAM: Theory and Practice, McGraw-Hill
2. Hearn E J and Baker M P, Computer Graphics, Pearson.



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3. Chandrupatla T A and Belegundu A D, Introduction to Finite Elements in Engineering, PHI.
4. Logan D, A First Course in the Finite Element Method, Cengage.
5. David F. Rogers and J. Alan Adams, "Mathematical Elements for Computer Graphics", McGraw-Hill.
6. S.S.Rao, "Engineering Optimization", A wiley –Interscience.

List of Experiments:

1. Prepare a programme for plotting lines and curves using algorithms learned.
2. Introductory exercise for 3-D modelling.
3. Exercise for advanced 3-D modelling.
4. Exercise for 3-D editing options.
5. Exercise for Assembly modelling.
6. Exercise for FEA of 1-D structural problems.
7. Exercise for FEA of trusses.
8. Exercise for FEA using Beam Element.
9. Exercise for FEA of 1-D thermal problems.
10. Exercise for FEA of 2-D structural problems.
11. Exercise for developing the optimization model of machine element using Johnson Method.

Major Equipment:

1. Computers / Workstations
2. CAD Software
3. FEA Software

List of Open Source Software/learning website:

1. www.nptel.ac.in/
2. <http://help.autodesk.com/view/fusion360/ENU/>.
<https://academy.autodesk.com/course/108871/introduction-cad-engineers>
3. <http://help.autodesk.com/view/fusion360/ENU/?learn=assemble>
4. <http://help.autodesk.com/view/fusion360/ENU/?learn=simulate>
5. <https://academy.autodesk.com/curriculum/introduction-cad-and-cae>
6. <https://www.youtube.com/watch?v=XmBNKNIz0rY>
7. <https://www.youtube.com/watch?v=DmWHKkBnw6o>



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Subject Code:3161907

Semester – VI

Subject Name: Basics of Industrial Engineering

Type of course: Professional Core Course

Prerequisite: Nil

Rationale:

Basics of Industrial Engineering course is to prepare students to understand different aspects like: Plant location and its selection, Plant layout within the plant. It also helps to understand and apply different concept of production planning and control. Study of productivity and Work-study are important tools, after studying it student are able to apply it in the industry for productivity improvement. This course gives idea about how to prepare job plan, and also gives knowledge of industrial legislation. Finally it provides knowledge about Statistical quality control, entrepreneurship and waste management.

Teaching and Examination Scheme:

Teaching Scheme			Credits C	Examination Marks				Total Marks
L	T	P		Theory Marks		Practical Marks		
				ESE (E)	PA (M)	ESE (V)	PA (I)	
3	0	2	5	70	30	30	20	150

Content:

Sr. No.	Content	Total Hrs
1	Location Selection and Plant Layout: Nature of Location Decision, Importance of Plant Location, Dynamic Nature of Plant Location, Choice of site for selection, Comparison of location. Principles of Plant layout and Types, factors affecting layout, methods, factors governing flow pattern, travel chart, analytical tools of plant layout, layout of manufacturing shop floor, repair shop, services sectors and process plant. Quantitative methods of Plant layout: CRAFT and CORELAP, Relationship diagrams.	08
2	Production Planning and Control: Types of Production systems and their Characteristics, functions and objectives of Production Planning and Control, Sales forecasting: Techniques and Applications, Steps of Production Planning and Control: Process planning, Loading, Scheduling, Dispatching and Expediting with illustrative examples, Introduction to line of balance, assembly line balancing, and progress control.	06
3	Productivity and Work Study: Definition of productivity, application and advantages of productivity improvement tools, reasons for increase and decreases in productivity. Areas of application of work study in industry. Reaction of management and labour to work study.	08



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	<p>Method Study: Objectives and procedure for methods analysis, Recording techniques, Operations Process Chart, Flow Process Chart, Man-Machine, Multiple Activity Chart, Travel Chart, and Two Handed process chart, String Diagram, Therbligs.</p> <p>Micro motion and macro-motion study: Principles of motion economy, Normal work areas and work place design.</p> <p>Work Measurement: Objectives, Work measurement techniques – time study, work sampling, pre-determined motion time standards (PMTS) Determination of time standards. Observed time, basic time, normal time, rating factors, allowances, and standard time. Introduction to ergonomics.</p>	
4	<p>Job Evaluation and Wage Plan: Objective, Methods of job evaluation, job evaluation procedure, merit rating (Performance appraisal), method of merit rating, wage and wage incentive plans</p>	04
5	<p>Industrial Legislation: Need for Industrial legislation, Factories act 1948, Industrial dispute act 1947, The Indian trade unions act 1926, Industrial employment act 1946, Payment of wage act 1936, Workmen compensation act 1923, Payment of bonus act 1965, Employees provident fund scheme 1952.</p>	04
6	<p>Entrepreneurship: Concept, product identification, infrastructure facilities, preparation of project report, sources of industrial finance, Resources allocation, Government incentives to entrepreneurs.</p>	04
7	<p>Inspection and Quality Control: Inspection – functions, types, objectives and benefits, quality control principles, Concepts of quality circles, Total quality management, Quality assurance, Quality audit, Basic Concept ISO 9000, ISO 14000 and QS 9000, Six sigma: Concept, Principle, Methodology, Scope, Advantage and limitations.</p> <p>Statistical Quality Control: SQC Concept, variable and attributes, normal distribution curves and its property charts for variable and attributes and their applications and interpretation (analysis) process capability. Acceptance sampling, sampling plans, OC curves and AOQ curves.</p>	08
8	<p>Waste Management: Introduction and Meaning, Reasons for generation and accumulation of obsolete, Surplus and scrap Items, Identification and control of waste, disposal of scrap.</p>	03
	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.



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Reference Books:

1. Work study by International Labour Organization, ILO
2. Manufacturing Organization and Management, Harold Amrine, John Ritchey, Moodie, Kmec, 6th Ed., Pearson
3. Industrial Engineering and Management, by Praveenkumar, Pearson
4. Production System, Planning, Analysis and Control – By J.L. Riggs 3rd ed. Wiley
5. Production and Operations Management – By R. Panneerselvam, PHI Private Ltd.,
6. Production and Operations management by S Anilkumar, Suresh, New Age International Publications.

Course Outcomes: Students will be able to:

Sr. No.	CO statement	Marks % weightage
CO-1	Describe location decision, Site selection and Plant layout	20
CO-2	Demonstrate Production Planning and Control	25
CO-3	Analyse Productivity, Work study techniques, Job evaluation and Wage plan	20
CO-4	Illustrate Statistical Quality Control and Inspection	25
CO-5	Understand Industrial Legislation and Entrepreneurship and waste management.	10

Term Work:

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

List of Experiments:

1. Case study demonstration on location decision and site selection
2. Tutorials on Production Planning and Control
3. Case study on plant layout problem
4. Exercise on OPC, FPC, Travel chart
5. Exercise on Method study, Motion Study and work measurement
6. Problems on wage and incentive plans
7. Exercise on statistical quality control techniques
8. Case study analysis of Entrepreneurship
9. Exercise on Waste management

Major Equipment:

Nil

List of Open Source Software/learning website:

1. Report preparation on plant layout and site selection for different industries
2. Operation and flow process chart for different products
3. Work Measurement case study
4. Real life problems on statistical quality control problems



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Subject Code: 3161910

Semester – 6

Subject Name: Applied Thermodynamics

Type of course: Professional Core

Prerequisite: -

Rationale: A Mechanical Engineer must have good understanding of energy conversion in various thermal devices and must understand phenomena occurring in high speed compressible flow.

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks				Total Marks
L	T	P		Theory Marks		Practical Marks		
			ESE (E)	PA (M)	ESE (V)	PA (I)		
4	0	2	5	70	30	30	20	150

Content:

Sr. No.	Content	Total Hrs
1	Properties of gases and gas mixtures: Avogadro's law, equation of state, Vander Waal's equation, reduced properties, law of corresponding states, compressibility chart, internal energy; enthalpy and specific heat of a gas mixtures	4
2	Psychrometry: Dalton's law of partial pressure, Properties of moist air, temperature and humidity measuring instruments, psychrometric chart, psychrometric processes such as sensible heating and cooling, heating and humidification cooling and dehumidification, chemical dehumidification, adiabatic saturation	8
3	Refrigerant and Refrigeration cycles: Classification, nomenclature and desirable properties of refrigerant, secondary refrigerants, ODP and GWP, Compound compression with intercooler, flash gas removal and flash intercooler, Desirable characteristics of refrigerant absorbent pair for vapor absorption cycle, Simple H ₂ O -NH ₃ cycle, LiBr ₂ – H ₂ O cycle and its working	8
4	Fuel Air and Actual Cycles: Assumptions for fuel-air cycles, reasons for variation of specific heats of gases, change of internal energy and enthalpy during a process with variable specific heats, isentropic expansion with variable specific heats, effect of variable specific heats on Otto, Diesel and Dual cycle, dissociation, comparison of air standard and fuel air cycles, effect of operating variables, comparison of air standard and actual cycles, effect of time loss, heat loss and exhaust loss in petrol and diesel engines,	8
5	IC engine performance and Emissions: Measurement of indicated power, brake power, friction power, fuel consumption and emission, calculation of brake thermal efficiency, brake power and brake specific fuel consumption, variable compression ratio engines, heat balance sheet, principal engine emissions, source of engine emissions, emission measurement instruments like five gas analyzer and smoke meter, Euro and Bharat standards of emissions of	10



GUJARAT TECHNOLOGICAL UNIVERSITY

Bachelor of Engineering

Subject Code: 3161910

	I.C. Engines, Emission control methods like Air injection, Exhaust gas recirculation, Catalytic converter, Evaporative emissions control	
6	Fundamentals of compressible flow: Ideal gas relationship, Adiabatic energy equation, Mach number and its significance, Mach waves, Mach cone and Mach angle, static and stagnation states, relationship between stagnation temperature, pressure, density and enthalpy in terms of Mach number, stagnation velocity of sound, reference speeds, various regions of flow, Effect of Mach number on compressibility, Area velocity relationship.	8
7	Reciprocating Compressors: Construction and working, Multistage conditions for minimum work, Intercooling, Efficiency and control of air compressors Centrifugal Compressors: Essential parts, Static and total head properties, Velocity diagram, Degree of reaction, surging and choking, Losses in centrifugal compressor Axial Flow Compressors: Construction of an axial flow compressor, Aerofoil blading, Lift and drag, Performance characteristics	10

Suggested Specification table with Marks (Theory):

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
20	30	50	0	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. Engineering Thermodynamics by P.K. Nag, McGraw-Hill Education
2. Refrigeration and Air Conditioning by C P Arora, McGraw-Hill India Publishing Ltd.
3. Internal Combustion Engines by Ganeshan, McGraw-Hill Education
4. Turbines, Compressors and Fans by S.M. Yahya., TMH Publishers
5. Fundamentals of Internal Combustion engine by H.N.Gupta, PHI Learning
6. Internal Combustion Engine Fundamentals by John B. Heywood, McGraw Hill Education Pvt Ltd.

Course Outcomes:

Sr. No.	CO statement	Marks % weightage
CO-1	To apply various gas laws of real gas and their mixture, to make use of psychrometric properties to identify basic psychrometric processes.	22
CO-2	To experiment with vapor compression and vapor absorption systems.	14
CO-3	To explain fuel-air and actual cycles for IC engines and to develop understanding of IC engines testing and their emission norms.	32
CO-4	To apply fundamental of compressible fluid flow.	14
CO-5	To demonstrate various air compressors and experiment with them.	18



GUJARAT TECHNOLOGICAL UNIVERSITY

Bachelor of Engineering
Subject Code: 3161910

List of Experiments:

1. To understand different components of VCR system and to determine its COP.
2. To perform different psychrometric processes and analyze the same using psychrometric chart.
3. To understand construction and working of window air-conditioner/ split air-conditioner and to determine its capacity.
4. To determine COP and apparatus dew point of an air conditioning test rig.
5. To determine $(COP)_C$ and $(COP)_H$ of heat pump.
6. To determine saturation efficiency of air cooler/air washer.
7. Performance test of 4 stroke Petrol Engine.
8. Performance test of 4 stroke Diesel Engine.
9. Determination of friction power of multi cylinder petrol engine using Morse Test Method.
10. Performance test on Reciprocating compressor.
11. To study the constructional details of axial flow compressor and draw its characteristics curve.
12. Performance test on Centrifugal compressor.

Major Equipment: VCR cycle test rig, Mechanical heat pump, psychrometric processes apparatus, window/split air conditioners, air conditioning test rig, air cooler/air washer, 4 stroke petrol engine, 4 stroke diesel engine, Morse test apparatus, reciprocating compressor test rig, axial flow compressor test rig, centrifugal compressor test rig

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



GUJARAT TECHNOLOGICAL UNIVERSITY

Bachelor of Engineering

Subject Code: 3161911

Semester –6

Subject Name: Design of Heat exchangers

Type of course: Elective

Prerequisite: -

Rationale: The course is design to provide fundamental knowledge of different type of heat exchangers used for various thermal applications and to learn the sizing of heat exchangers, thermal analysis for various heat exchange applications.

Teaching and Examination Scheme:

Teaching Scheme			Credits C	Examination Marks				Total Marks
L	T	P		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	Different classification and basic design methodologies for heat exchanger: Classification of heat exchanger, selection of heat exchanger, overall heat transfer coefficient, LMTD method for heat exchanger analysis for parallel, counter, multi-pass and cross flow heat exchanger, e-NTU method for heat exchanger analysis, fouling, cleanliness factor, percent over surface, techniques to control fouling, additives, rating and sizing problems, heat exchanger design methodology	11
2	Design of double pipe heat exchangers: Thermal and hydraulic design of inner tube and annulus, hairpin heat exchanger with bare and finned inner tube, total pressure drop	8
3	Design of Shell & tube heat exchangers: Basic components, basic design procedure of heat exchanger, TEMA code, J-factors, conventional design methods, Bell-Delaware method.	10
4	Design of compact heat exchangers: Heat transfer enhancement, plate fin heat exchanger, tube fin heat exchanger, plate heat exchanger, heat transfer and pressure drop	10
5	Heat Transfer Enhancement and Performance Evaluation: Enhancement of heat transfer, Performance evaluation of Heat Transfer Enhancement technique. Introduction to pinch analysis.	6

Suggested Specification table with Marks (Theory):

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
10	20	50	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.



GUJARAT TECHNOLOGICAL UNIVERSITY

Bachelor of Engineering

Subject Code: 3161911

Reference Books:

1. Heat Exchanger Selection, Rating and Thermal Design by Sadik, Kakac, CRC Press
2. Fundamentals of Heat Exchanger Design by Ramesh K Shah, Wiley Publication
3. Compact Heat Exchangers by Kays, V.A. and London, A.L., McGraw Hill
4. Heat Exchanger Design Handbook by Kuppan, T, Macel Dekker, CRC Press
5. Heat Exchanger Design Hand Book by Schunder E.U., Hemisphere Pub.
6. Process Heat transfer by Donald Q Kern, McGraw Hill

Course Outcomes:

Sr. No.	CO statement	Marks % weightage
CO-1	To select appropriate heat exchanger for the given application and to measure the performance degradation of heat exchangers subject to fouling.	24
CO-2	To analyse thermal and hydraulic performance of double pipe and shell and tube heat exchangers.	40
CO-3	To analyse thermal and hydraulic performance of different types of compact heat exchangers.	22
CO-4	To compare various heat transfer enhancement techniques and to apply process optimization techniques for heat exchanger design	14

List of Experiments:

1. Design of heat exchange equipment by using LMTD method.
2. Design of heat exchange equipment by using effectiveness– NTU method.
3. Measure the effectiveness of shell and tube heat exchanger.
4. Design and analysis of Parallel flow and Counter flow heat exchanger.
5. Design and analysis of Shell and tube type heat exchanger.
6. Design and analysis of Plate type heat exchanger.

Major Equipment: Shell and tube heat exchanger, Plate type heat exchanger, Tube and tube heat exchanger, Compact heat exchanger

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



GUJARAT TECHNOLOGICAL UNIVERSITY

Bachelor of Engineering
Subject Code: 3161912
Semester –VI
Subject Name: Gas Dynamics

Type of course: Elective

Prerequisite: -

Rationale: The course is design to provide fundamental knowledge of different type of heat exchangers used for various thermal applications and to learn the sizing of heat exchangers, thermal analysis for various heat exchange applications.

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks				Total Marks
L	T	P		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	Fundamentals of compressible flow: Ideal gas relationship, The adiabatic energy equation, Mach number and its significance, Mach waves, Mach cone and Mach angle, static and stagnation states, relationship between stagnation temperature, pressure, density and enthalpy in terms of Mach number, stagnation velocity of sound, reference speeds, various regions of flow, Effect of Mach number on compressibility, Area velocity relationship	8
2	One Dimensional Isentropic flow: General features of isentropic flow, performance curve, Comparison of adiabatic and isentropic process, One dimensional isentropic flow in ducts of varying cross-section-nozzles and diffusers, operation of nozzles under varying pressure ratio, mass flow rate in nozzles, critical properties and choking, area ratio as function of Mach number, Impulse function, non-dimensional mass flow rate in terms of pressure ratio, area ratio and Mach number, Working charts and gas tables, Application of Isentropic flow. Wind tunnels: Requirements, classification and applications of different types of wind tunnels.	10
3	Normal shock Waves: Development of shock wave, Thickness of shock wave, governing equations, Strength of shock waves, Prandtl-Mayer relation, Rankine-Hugoniot relation, Mach number in the downstream of normal shock, variation of flow parameters across the normal shock, normal shock in Fanno and Rayleigh flows, impossibility of a rarefaction shock, supersonic diffusers, supersonic pitot tube	9
4	Flow in constant area duct with friction (Fanno flow): Fanno curve and Fanno flow equations, solution of Fanno flow equations, variation of flow properties, variation of Mach no. with duct length, isothermal flow in constant area duct with friction, tables and charts for Fanno flow, Experimental friction coefficients	8
5	Flow in constant area duct with heat transfer (Rayleigh flow): Simple heating relation of a perfect gas, Rayleigh curve and Rayleigh flow equations, variations of flow properties, maximum heat transfer, tables and charts for Rayleigh flow	7



GUJARAT TECHNOLOGICAL UNIVERSITY

Bachelor of Engineering

Subject Code: 3161912

Suggested Specification table with Marks (Theory):

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
7	10	17	18	11	7

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. Fundamental of Compressible flow, S. M. Yahya, New age international Publication, Delhi
2. Fundamentals of compressible fluid dynamics-P. Balachandran, PHI Learning, New Delhi
3. The dynamics and thermodynamics of Compressible fluid low Volume-I, Ascher H. Shapiro, the Ronald Press Company, New York.
4. Gas Dynamics, E. Rathakrishnan, PHI Learning Pvt. Ltd.
5. Gas Dynamics and Jet Propulsion-P. Murugaperumal, Scitech Publication, Chennai.
6. Modern Compressible Flow: With Historical Perspective, John D. Anderson, McGraw-Hill Higher Education.

Course Outcomes:

Sr. No.	CO statement	Marks % weightage
CO-1	To understand the fundamentals of compressible flow.	20
CO-2	To formulate and develop the flow parameters for isentropic flow.	30
CO-3	To analyze the effect of normal shock in compressible flow.	20
CO-4	To study the effect of friction on compressible flow in constant area duct.	20
CO-5	To study the flow through constant area duct with heat transfer	10

List of Experiments:

- 1) To study the energy equation for flow and non-flow process, significance of Mach number, Mach cone, Mach angle and various regions of flow.
- 2) To study the static and stagnation properties of compressible fluid in terms of Mach number and its effect on compressibility.
- 3) To study the expansion in nozzle, compression in diffuser, variation of area ratio with Mach number and impulse function for the isentropic flow.
- 4) To study the effect of pressure ratio and isentropic flow through convergent, convergent-divergent nozzle and diffuser.
- 5) To study the different types of wind tunnels.
- 6) To study the development of shock wave, Rarefaction of wave and develop the Prandtl-Mayer equation for normal shock wave.
- 7) To study the effect of Mach number on static and stagnation properties across the normal shock.
- 8) To develop the governing equation for Fanno flow and its solution.
- 9) To study the variation of flow properties for Fanno flow.



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Subject Code: 3161912

10) To study the frictionless flow process with heat transfer in constant area duct and develop Rayleigh flow relations.

Major Equipment: Wind tunnel

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

GTUQuestionPapers.com



GUJARAT TECHNOLOGICAL UNIVERSITY

Bachelor of Engineering

Subject Code: 3161913

Semester – VI

Subject Name: Industrial Safety and Maintenance Engineering

Type of course:

Prerequisite:

Rationale:

This subject focuses on applying engineering concepts to the optimization of equipment, procedures, and departmental budgets to achieve better maintainability, reliability, and availability of equipment. Maintenance, and hence maintenance engineering, is increasing in importance due to rising amounts of equipment, systems, machineries and infrastructure. The subject also focuses on various safety engineering aspects like understanding hazards, quantifying risk, design for Safety, investigating accident, safety education and training.

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks				Total Marks
L	T	P		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	Quality, Reliability and Maintainability(QRM): Productivity; Quality and Quality circle in Maintenance, engineering Reliability, Reliability Assurance through Redundancy, Maintainability and maintainability improvement, Maintainability vis a vis Reliability.	06
2	Maintenance jobs and Technologies: Wear and service life of equipment: Methods of assembly and fitting – assembly of keyed joints, splined joints, fixed joints, assembly of ball and roller bearings, repairs and assembly of gears. Wear of machines- types and reasons of wear, defects due to wear of equipment, corrosion and its prevention. Recovery and strengthening of machine elements various methods of recovery and increasing service life.	06
3	Defect list Generation and Defect/Failure Analysis: Defect Generation: types of failure, defect reporting and recording, defect analysis, failure analysis, equipment downtime analysis, breakdown analysis: FTA, FMTA, FMECA)	06
4	Maintenance Types/Systems: Planned and unplanned Maintenance, Breakdown Maintenance, corrective Maintenance, Opportunistic Maintenance, Routine Maintenance, Preventive Maintenance, Predictive Maintenance, Condition Base Maintenance System (CBMS): Online offline Monitoring, Visual and Temperature Monitoring, Leakage Monitoring, Vibration Monitoring: causes,	08



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Bachelor of Engineering

Subject Code: 3161913

	Identification and monitoring. Ferrography, Spectroscopy, Cracks Monitoring. Design Out maintenance, Selection of Maintenance Systems.	
5	Maintenance Planning and Scheduling: Factors involved in effective planning of maintenance work, Various methods of scheduling work, Categorization of plant/equipment for the purpose of priorities. Short term and Long Term Maintenance Plans: Major repair, Capital Repair and Annual Overhauls, Renovation, Revamping and Modernization.	06
6	Safety Engineering: Introduction, Hazard and Operability Study (HAZOP), Fundamental of Industrial Safety, Types and Categorization of Accidents. Accidents preventions, Safety Training. Onsite offsite Emergency Plans, Job Safety Analysis (JSA), Safety Survey, Reporting of accidents and dangerous occurrence.	08
7	Safe Design and Operation of Plants: Procedure for Ensuring Safety in Planning, Building and Operating Plants: Process Design, Planning, Construction and Commissioning of Plants, Alarm and Hazard Defense Plans, Information of the Public. Safety measures: Inherent Safety Measures, Passive Safety Measures, Active Safety Measures, Organizational Measures, Design of Safety Systems. Plant Layout and Spacing. Personal Safety and Personal Protective Equipment	05
	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
20	30	20	20	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. Maintenance Engineering and management by R.C. Mishra & K. Pathak, PHI publication
2. Maintenance Engineering and management by K. VenkatRamana, PHI publication
3. Maintenance of Ind. Equipments-by Gellery & Pakelts, MIR publications
4. Ind. Maintenance by H.P. Garg, S. Chand & company
5. Modern Maintenance Management, by Miller & Blood
6. Industrial Safety and Maintenance by Deshmukh, Tata McGraw Hill
7. Industrial Safety Health Environment and Security By Basudev Panda, University Science Press
8. Process and Plant Safety, Hauptmanns, Ulrich, Springer Publication.



GUJARAT TECHNOLOGICAL UNIVERSITY

Bachelor of Engineering
Subject Code: 3161913

Course Outcomes: Students will be able to:

Sr. No.	CO statement	Marks % weightage
CO-1	Describe Quality, Reliability and Maintainability	10
CO-2	Understand the principles, functions and practices adapted in industry for the successful management of maintenance activities.	15
CO-3	Demonstrate Defects and Failure analysis and different types of maintenance system	25
CO-4	Differentiate various Maintenance Planning and Scheduling techniques.	25
CO-5	Demonstrate safety practice aspects in industry.	25

Term Work:

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

List of Experiments:

1. Study about maintainability.
2. Study about wear and service life of equipment.
3. Study about maintenance and repair of production equipment.
4. Study about restoring of the guide ways of machine tools.
5. To study maintenance planning and scheduling.
6. Study about preventive maintenance.
7. Study about industrial safety.
8. Study about accidents and industrial hazards.
9. Study about safety measurement.
10. Study about legal aspect of safety and safety education.

Major Equipment:

List of Open Source Software/learning website:

NPTEL notes and videos



GUJARAT TECHNOLOGICAL UNIVERSITY

Bachelor of Engineering

Subject Code: 3161914

Semester –VI

RENEWABLE ENERGY ENGINEERING

Type of course: Elective

Pre requisite: Fluid Mechanics, Heat Transfer

Rationale: The course is designed to give knowledge of various renewable energy sources, systems and applications in the present context and need.

Teaching and Examination Scheme:

Teaching Scheme			Credits C	Examination Marks				Total Marks
L	T	P		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	% Weightage
1	Scenario of Renewable Energy (RE) Sources: Need of RE, advantages and limitations of RE, present energy scenario of conventional and RE sources.	1	2
2	Solar Energy: Energy available from the sun, spectral distribution, solar radiation outside the earth's atmosphere and at the earth's surface, solar radiation geometry, Instruments for solar radiation measurements, empirical equations for prediction of availability of solar radiation on horizontal, radiation on and tilted surface. Solar energy conversion into heat, types and working of solar collectors, evacuated and non-evacuated solar air heater, concentrated collectors, losses in liquid flat plate collector, thermal analysis of liquid flat plate collector, air heater and cylindrical parabolic concentrating collector, solar energy thermal storage, Solar space heating and cooling of buildings, solar pumping, solar cooker, solar still, solar drier, solar refrigeration and air-conditioning, solar pond, heliostat, solar furnace, photovoltaic system for power generation, solar cell modules and arrays, solar cell types, material, applications, advantages and disadvantages.	19	42
3	Wind Energy: Energy available from wind, basics of lift and drag, basics of wind energy conversion system, Betz limit theory, effect of density, angle of attack and wind speed, wind mill rotors, horizontal and vertical axes rotors, drag, lift, torque and power coefficients, tip speed ratio, solidity of turbine, wind turbine performance	8	18



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	curves, wind energy potential and site selection, basics of wind farm, Safety and environmental aspects, wind energy potential and installation in India.		
4	Bio Energy: Biomass energy – modern energy carrier, energy plantation, gasification, types and applications of gasifiers, types of biogas plants, design of biogas plant, factors affecting biogas generation. advantages and disadvantages.	4	9
5	Ocean Energy: OTEC principle, open, closed and hybrid cycle OTEC system, Energy from tides, estimation of tidal power, tidal power plants, single and double basin plants, site requirements, advantages and limitations Wave energy: Wave energy conversion devices, advantages and disadvantages, Present scenario. Geothermal energy: Introduction, vapor and liquid dominated systems, binary cycle, hot dry rock resources, magma resources, advantages and disadvantages, applications. MHD Power generation: concept and working principle.	7	16
6	Economic Analysis: Initial and annual cost, Basic definitions Fundamentals of economic analysis, time value of money, payback period, present worth calculations, repayment of loan in equal annual installments, annual solar savings, cumulative saving and life cycle cost analysis, economic analysis of solar system, clean development mechanism	6	13

Suggested Specification table with Marks (Theory):

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
10	14	20	10	10	6

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. Solar Energy: Principles of Thermal Collection and Storage, S. P. Sukhatme and J. K. Nayak, McGrawHill Education
2. Solar Engineering of Thermal Processes, John A. Duffie, William A. Beckman, John Wiley, New York
3. Non-conventional Energy Resources, B. H. Khan, Tata McGraw Hill
4. Non-Conventional Resources of Energy, G. S. Sawhney, PHI
5. Non-conventional energy resources, Shobh Nath Singh, Pearson India
6. Solar Energy Engineering, Soteris Kalogirou, Elsevier/Academic Press.
7. Principles of Solar Energy, Frank Krieth & John F Kreider, John Wiley, New York



GUJARAT TECHNOLOGICAL UNIVERSITY

Bachelor of Engineering
Subject Code: 3161914

Course Outcomes:

Sr. No.	CO statement	Marks % weightage
CO-1	To design and develop solar systems for various applications To estimate solar radiation on the various surfaces and its applications for thermal and photovoltaic system.	20
CO-2	To analyze the performance of various solar collectors.	20
CO-3	To evaluate the potential of wind energy conversion systems.	15
CO-4	To illustrate Bio energy, Wave energy, Ocean energy and Geothermal Energy.	30
CO-5	To evaluate the life cycle cost and carry out economic analysis of renewable energy sources.	15

List of Experiment:

- 1) To study and measure the solar radiation on horizontal and tilted surface using solar radiation measuring instruments.
- 2) To evaluate the performance of solar liquid flat plate collector.
- 3) To evaluate the performance of solar air heater.
- 4) To evaluate the performance of concentrating collectors.
- 5) To evaluate the performance of solar still.
- 6) To evaluate the performance of box type solar cooker.
- 7) To study the various types of wind mill and evaluate the performance parameter of wind. mill.
- 8) To study the various types of gasifier and biogas plant.
- 9) To study the ocean energy, wave energy, geothermal energy conversion systems.
- 10) To estimate the economics of the solar energy conversion equipment.

Major Equipment:

Pyranometer, Sunshine recorder, Solar power meter, Solar liquid flat plate collector, Solar air heater, Cylindrical Parabolic Collector, Compound parabolic collector, Box type solar cooker, Solar drier, Solar still, wind mill.

Requirement: The paper setter is required to ensure that empirical correlations and relevant data for analysis of problems be provided in question paper. No separate Energy data book is required to be provided in examination.

List of Open Source Software/learning website:

- 1) <http://vlab.amrita.edu/>
- 2) <https://nptel.ac.in/courses/112/105/112105051/>
- 3) <https://nptel.ac.in/courses/108/105/108105058/>
- 4) <https://nptel.ac.in/courses/121/106/121106014/>
- 5) <http://ocw.mit.edu/courses/energy-courses/>



GUJARAT TECHNOLOGICAL UNIVERSITY

Bachelor of Engineering

Subject Code: 3161915

Semester –VI

Subject Name: Computational Fluid Dynamics

Type of course: Professional core course

Prerequisite: Basic course on Fluid Mechanics, Thermodynamics and Numerical Methods

Rationale: This is an introductory course in CFD. In this course, students will be exposed to basics of CFD. Students will gain knowledge on FD/ FV strategy, formulation of the problem and solution techniques.

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks				Total Marks
L	T	P		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	Weight age
1	Introduction to CFD & Principles of Conservation: What is CFD? Experimental, Theoretical and Numerical Approach, Historical Background, Applications of CFD, Fundamental principles of conservation, Reynolds transport theorem, Conservation of mass, Navier-Stokes equation, Conservation of Energy, General scalar transport equation.	04	10%
2	Classification of Partial Differential Equations and Physical Behavior: Introduction, Physical Classification: Equilibrium Problems & Marching Problems, Mathematical classification of Partial Differential Equation: Elliptic, Parabolic and Hyperbolic partial differential equations.	04	10%
3	Fundamentals of Discretization & Finite Difference Method : Basics of Discretization (FDM, FVM & FEM), Finite Difference: Introduction, Finite Difference representation of PDEs, Truncation error, Round-off error, Discretization error, Explicit and Implicit Methods, Stability analysis, TDMA (Tridiagonal matrix algorithm), ADI (Alternative Direction Implicit) method, First order Upwind scheme, Lax-Wendroff Method, Second order Upwind scheme	10	20%
4	Finite Volume Method for steady diffusion problems and advection -diffusion problem: Basic concepts of Finite Volume method (FVM), Finite Volume method for 1-D steady state diffusion type problem, Finite Volume method for 2-D steady state diffusion type problem, Types of Boundary Conditions, Different advection schemes, Generalized advection -diffusion formulation, Finite volume discretization of two-dimensional advection -diffusion problem, The concept of false diffusion	12	25%
5	Numerical Solutions of Navier-Stokes Equations: Discretization of the Momentum Equation, Stream Function-Vorticity approach and Primitive variable approach, Staggered grid and Collocated grid, SIMPLE Algorithm, SIMPLER Algorithm, SIMPLEC Algorithm, PISO Algorithm	08	15%



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Subject Code: 3161915

6	Numerical Grid Generation: Definition of Grid, need for grid, Geometric modelling and surface grid, Algebraic grid generation, Automatic generation of unstructured grid, Structured and Unstructured grid, Multi Block grid, Types of grid element, factors affecting the grid	04	10%
7	Basics of Turbulence Modeling: Introduction to Reynolds Averaged Navier Stokes Modeling, Zero, One and Two equation models	03	10%

Suggested Specification table with Marks (Theory):

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
30%	30%	20%	10%	10%	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. Anderson J.D. (1995) Computational Fluid Dynamics: The Basics with Applications, McGraw-Hill Inc.
2. Anderson, D.A., Tannehill, J.C. and Pletcher, R.H. (1997). Computational Fluid Mechanics and Heat Transfer, Taylor & Francis
3. Versteeg, H. K. and Malalasekara, W. (2008), Introduction to Computational Fluid Dynamics: The Finite Volume Method. Second Edition (Indian Reprint) Pearson Education
4. T. J. Chung, Computational Fluid Dynamics, Cambridge University Press.
5. S. V. Patankar, Numerical Heat Transfer and Fluid Flow, McGraw-Hill

Course Outcomes:

Upon completion of this course students should be able:

Sr. No.	CO statement	Marks % weightage
CO1	To understand the underlying theoretical basics of CFD.	25%
CO2	To Illustrate various discretization techniques used to solve PDE.	25%
CO3	Apply the various discretization methods, solution procedures to solve flow problems.	20%
CO4	Categorize different numerical techniques used to solve fluid flow problems.	15%
CO5	Understand various turbulence models to solve turbulent flow problems.	15%

List of Experiments:

1. Introduction to CFD software.
2. To simulate Lid driven cavity flow.
3. To simulate flow through forward facing step (FFS).
4. To simulate flow through backward facing step (BFS).
5. To simulate flow over a Flat Plate.
6. To simulate flow over a cylinder.
7. To simulate flow through C-D Nozzle.
8. To simulate Flow over an Airfoil.



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Subject Code: 3161915

Equipment / Computational facility:

Practical aspect of the subject is based on computation work so high configuration / specification computer systems are mandatory.

Software Packages:

- Open FOAM
- Scilab

List of Open Source Software/learning website:

<https://nptel.ac.in/>

www.cfd-online.com

GTUQuestionPapers.com



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Bachelor of Engineering

Subject Code: 3161916

Semester – VI

Subject Name: Product Development and Entrepreneurship

Type of course:

Prerequisite: Nil

Rationale:

Students will develop skills for evaluating, articulating, refining, and pitching a new product or service offering, either as a start-up business or a new initiative within an existing firm. This course is appropriate for all students interested in innovation and design as necessary components of new businesses today. The aims to acquaint the students with challenges of starting new ventures and enable them to investigate, understand and internalize the process of setting up a business.

Teaching and Examination Scheme:

Teaching Scheme			Credits C	Examination Marks				Total Marks
L	T	P		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	Product Development Processes: Characteristics of Successful Product development, Generic development process, Concept development: Concept generation process, Concept selection, Concept Embodiment, Process flows. Product life cycles, The challenges of Product development. Reverse Engineering and Redesign Product development Processes.	06
2	Product Planning and Customer Need: Identifying Opportunities, Evaluate and Prioritize, Allocate resources and scheduling tools. Identifying customer need: Types of customer needs, Customer need models. Gathering Customer needs: Need Gathering Methods, Conducting Interviews: Like Dislike Method, Articulated-Use Method, Product feel and Industrial Design. Organizing and Prioritizing Needs: Grouping Interpreted needs, Affinity Diagram, Determining need Importance, Customer use patterns, Customers need Documentation.	07
3	Product Configuration and Design for Function: Design for function techniques, Function analysis, and function family tree. Design Evaluation: Design for manufacturing methodology, Design for assembly methodology, Additional Assembly evaluation methods. Product evaluation: Product design for disassembly, Evaluation of Product for disassembly aspects in products, Design for Product maintenance. Product specifications.	08
4	Product Architecture and virtual Product Prototyping:	06



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Subject Code: 3161916

	Product Architectures type, Product Modularity and types, Modular design and methods. Advance functional methods: Function dependency, Module heuristics and application. Introduction to virtual reality, Design using virtual prototyping, Application of digital tools, Introduction to Additive manufacturing.	
5	Entrepreneurship: Concept, knowledge and skills requirement; characteristic of successful entrepreneurs; role of entrepreneurship in economic development; entrepreneurship process; factors impacting emergence of entrepreneurship; managerial vs. entrepreneurial approach and emergence of entrepreneurship.	04
6	Starting the venture: Competitor and industry analysis; feasibility study: market feasibility, technical/operational feasibility, financial feasibility; drawing business plan; preparing project report; presenting business plan to investors.	04
7	Functional plans: marketing plan – marketing research for the new venture, steps in preparing marketing plan, contingency planning; organizational plan: form of ownership, designing organization structure, job design, manpower planning; Financial plan: cash budget, working capital, Performa income statement, Performa cash flow, Performa balance sheet, break even analysis.	06
8	Issues related to Product development and Entrepreneurship: Legal issues: intellectual property rights patents, trademarks, copy rights, trade secrets, licensing; franchising.	04
	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	10	30	30	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. Product Design for Engineers, By Devdas Shetty, Cengage Learning
2. Product Design, by Kevin Otto, Kristin wood, Pearson Education Inc.
3. Product design and development, by K.T. Ulrich and S.D. Eppinger, Tata McGraw Hill
4. Product Development, by Chitale & Gupta, Tata McGraw Hill



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5. The Mechanical Process Design, by David Ullman, McGraw hill Inc
6. Engineering Design Process, by Yousef Haik, T M M Shahin, Cengage Learning
7. Product design & process Engineering by Niebel & deeper, McGraw hill
8. New Product Development Timjones. Butterworth Heinmann, Oxford.
9. Assembly automation and product design – by Geoffrey Boothroyd, CRC Taylor & Francis
10. Entrepreneurship, Hisrich, Robert D., Michael Peters and Dean Shepherded, , Tata McGraw Hill, ND
11. Entrepreneurship, , Brace R., and R., Duane Ireland, , Pearson Prentice Hall, New Jersey (USA).
12. Entrepreneurship Development and Small Business Enterprises, Charantimath, Poornima, Pearson Education, New Delhi.

Course Outcomes: Students will be able to:

Sr. No.	CO statement	Marks % weightage
CO-1	Interpret Product design and development process.	10
CO-2	To frame customer specification to configure Product with function	30
CO-3	Select product architecture and virtual prototyping.	25
CO-4	Classify entrepreneurship for starting venture.	25
CO-5	Develop entrepreneurship functional plan with legal issues.	10

Term Work:

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

List of Experiments:

Major Equipment:

List of Open Source Software/learning website:

NPTEL notes and videos



GUJARAT TECHNOLOGICAL UNIVERSITY

Bachelor of Engineering

Subject Code: 3161917

Semester –VI

Subject Name: Computer Aided Manufacturing

Type of Course: Elective

Prerequisite: Manufacturing Processes, Manufacturing Technology

Rationale:

Computer Aided Manufacturing is highly demanded area now a day. Computer Aided Manufacturing deals with Design of components to manufacturing and also includes Planning and controlling the processes. Industries widely use CNC, FMS and Robotics technology now a day. Students will be familiar with its hardware and software and also able to write programs for machining.

Teaching and Examination Scheme:

Teaching Scheme			Credits C	Examination Marks				Total Marks
L	T	P		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 Hours
1	Computer Aided Manufacturing: CAM Concepts, Objectives & scope, Nature & Type of manufacturing system, Evolution, Benefits of CAM, Role of management in CAM, Concepts of Computer Integrated Manufacturing, Impact of CIM on personnel, Role of manufacturing engineers, CIM Wheel to understand basic functions.	04
2	NC/CNC Machine Tools: NC and CNC Technology: Types, Classification, Specification and components, Construction Details, Controllers, Sensors and Actuators, CNC hardware: Re circulating ball screw, anti friction slides, step/servo motors. Axis designation, NC/CNC tooling. Fundamentals of Part programming, Types of format, Part Programming for drilling, lathe and milling machine operations, subroutines, do loops, canned Cycles, parametric subroutines.	09
3	Programmable Logic Controllers: Relay Device components, Programmable controller architecture, programming a programmable controller, tools for PLC logic design.	02
4	Group Technology and CAPP: Introduction, part families, part classification and coding systems: OPITZ, PFA, FFA, Cell design, rank order clustering, composite part concepts, Benefits of group technology. Approaches to Process Planning, Different CAPP system, application and benefits.	06
5	Flexible Manufacturing System: Introduction & Component of FMS, Needs of FMS, general FMS consideration, Objectives, Types of flexibility and FMS, FMS lay out and advantages. Automated material handling system: Types and Application, Automated Storage and Retrieval System, Automated Guided Vehicles, Cellular manufacturing, Tool Management, Tool supply system, Tool Monitoring System,	07



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	Flexible Fixturing, Flexible Assembly Systems.	
6	Robot Technology: Introduction: Robot Anatomy, Laws of Robot, Human System and Robotics, Coordinate system, Specifications of Robot. Power sources, actuators and Transducers, Robotic Sensors, Grippers, Robot Safety, Robot Programming and Robot Applications, Economic Considerations of Robotics system, Robot Kinematics and Dynamics, Robot Arm Dynamics. Concepts of Computer Vision and Machine Intelligence.	07
7	Integrated Production Management System: Introduction, PPC fundamentals, Problems with PPC, Introduction to ERP. Just in Time philosophy: JIT & GT applied to FMS, concepts of Expert System in Manufacturing and Management Information System.	07

Suggested Specification table with %Marks (Theory):

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

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

Course Outcomes: Students will be able to:

Sr. No.	CO statement	Marks % weightage
CO-1	Illustrate Computer Aided Manufacturing with NC, CNC and PLC technology for Industry	30
CO-2	Describe the Group Technology and Computer Aided Process Planning.	15
CO-3	Describe Flexible Manufacturing System with tools and equipment's.	20
CO-4	Describe Robot technology for Computer Aided Manufacturing system.	15
CO-5	Demonstrate Integrated Production Management system.	20

Reference Books:

1. Computer Aided Manufacturing by Tien Chien Chang, Pearson Education.
2. Automation, Production Systems and Computer Integrated Manufacturing by Mikell P Groover, Pearson Education.
3. Robotics Technology and Flexible Automation, by S R Deb, S Deb, McGraw Hill Education Private Limited.
4. Flexible Manufacturing Cells and System -William. W. Luggen Hall, England Cliffs, Newjersy.
5. P.Radhakrishnan, "Computer Numerical Control ", New Central Book Agency, 1992.
6. Computer integrated manufacturing -S. Kant Vajpayee – Prentice Hall of India.
7. System Approach to Computer Integrated Manufacturing. Nanua Singh, Wiley and sons Inc, 1996.
8. Computer Aided Manufacturing- Rao, Tewari, Kundra, McGraw Hill, 1993.



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9. CAD/CAM, Principles and Applications –P N Rao, McGraw Hill, 2010.
10. CAD/CAM, Introduction, -Ibrahim Zeid, Tata McGraw Hill, 2007.

List of Experiments:

1. Study of Computer Integrated System: Basics, Types of Manufacturing, role of management and CIM wheel
2. NC/CNC technology: Definition, Classification, Specification, Construction details, Sensors and Actuators, and different controllers.
3. CNC part Programming: Lathe and Milling jobs
4. Exercise on PLC for Simple problems.
5. Problems on GT and Industrial case problems on coding
6. Problems on CAPP and Industrial case problems
7. Study of Flexible Manufacturing system
8. Study of Robotics Technology
9. Study of Expert System in Manufacturing and MIS

Major Equipment:

1. CNC Machine
2. Industrial Robot
3. Programming Software.
4. CAD on Cloud Free software like Fusion 360

List of Open Source Software/learning website:

1. www.nptel.ac.in
2. Videos on CNC programming, PLC, Robotics and FMS



GUJARAT TECHNOLOGICAL UNIVERSITY

Bachelor of Engineering (Part Time)

Subject Code: 3161918

TRIBOLOGY AND TEROTECHNOLOGY

SEMESTER: VI

Type of course: Post Graduate

Prerequisite: Zeal to learn the Subject

Rationale: Majority of mechanical equipment / mechanisms involve relative motion of links or parts. The course intends to impart concepts of tribology. Application of tribology in design of mechanical components is also introduced.

Teaching and Examination Scheme:

Teaching Scheme			Credits C	Examination Marks				Total Marks
L	T	P		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	% Weightage
1	Introduction Defining Tribology , Need of tribology, History of Tribology, Tribology in Design, Mechanical design of seal and gasket, Tribological design of seals and gasket, Tribology in Industry (Maintenance) , Machine components like seal, cam, journal bearings, magnetic bearing, roller bearing, gear, Defining Lubrication, Applications of lubricant, Basic Modes of Lubrication, Thick and thin lubrications, Lubrication mechanisms, Properties of Lubricants, Types of Lubricants, Solid lubricants, Semi-solid lubricant, Liquid lubricants, Gaseous lubricants, Lubricant Additives, Need of Additives, Types of additives, Interference between additives, Lubrication Selection.	06	12%
2	Friction, Wear and Boundary Lubrication Friction, Classification of friction, Laws of friction, Causes of dry friction, Theories of Dry Friction, Friction Measurement, Stick-Slip Motion and Friction Instabilities, Wear, Classification of wear, Factors affecting wear, Theories of Wear, Approaches to Friction Control and Wear Prevention, Boundary Lubrication, Application of coatings and different surface treatments in wear and friction control.	06	12%
3	Lubrication of Bearings Mechanics of Fluid Flow, Theory of hydrodynamic lubrication, Lubricant Viscosity, Mechanism of pressure development in lubricant film, Reynolds' Equation and its Limitations, Idealized Bearings, Infinitely long plane fixed sliders, Infinitely long plane pivoted sliders, Infinitely long journal bearings, Infinitely short journal bearings, Journal Bearings, Locating journal position, Lubricant supply in bearing, Design of journal bearings, Hydrodynamic thrust bearings, Fixed pad thrust bearing, Pressure Distribution, Tilting pad thrust bearing.	06	12%
4	Hydrostatic and Squeeze Film Lubrication: Hydrostatic Lubrication, Basic concept, Advantages and limitations, Viscous	06	12%



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	flow through rectangular slot, Types and configurations, Circular step thrust bearing, Rectangular thrust bearing, Hydrostatic journal bearing, Energy losses, Squeeze Film Lubrication, Basic concept, Squeeze action between circular flat plates, Squeeze action between rectangular plates, Squeeze action under variable and alternating loads, Engine Bearing Lubrication, Oil flow, Power loss, Temperature rise		
5	Elasto–Hydrodynamic Lubrication and Mixed Lubrication: Principles and Applications, Hertz Theory, Pressure–Viscosity Term in Reynolds’ Equation, Ertel–Grubin Equation, Numerical Method for Determining Oil Film Thickness in Elasto– Hydrodynamic Lubrication, Rolling Element Bearings, EHL of Gear–Teeth Contact, Boundary Lubrication, Effect of Surface Topography on Mixed Lubrication, Asperity Temperatures in Mixed Film Lubrication	05	11%
6	Tribological Aspects of Rolling Motion and Gears: Rolling Element Bearings, Tribology of rolling bearings, Friction and Wear of Spur Gears, Lubrication of Spur Gears, Surface Failures, Offline and online Monitoring of Gears	05	11%
7	Terotechnology and Total Productive Maintenance: Introduction, Terotechnology system, Terotechnology process, Strategies for Terotechnology, Training in Terotechnology, Practice of Terotechnology, Terotechnology and Total Productive Maintenance.	03	10%
8	Maintenance Management and Terotechnology: Objectivew of maintenance, Maintenance Principles, The maintenance strategies, Replacement strategy, System Approach to Maintenance managements, Impact of Terotechnology on Maintenance Management, Maintenance Costing, Life cycle costing,	05	11%
9	Fault Analysis Logical Fault Finding,, Failures and Their Causes, Failure Modes and Effect Analysis, Terotechnology and Tribo Analysis, Tribological Failure. Tribological Failures Examples and Cases	03	9%

Reference Books:

1. Fundamentals of Engineering Tribology with Application, Harish Hirani, Cambridge University Press.
2. Applied Tribology: Bearing Design and Lubrication, M. M. Khonsari, E. R. Booser, Wiley.
3. Principles and Application of Tribology, B. Bhushan, Wiley.
4. Engineering Tribology, J. A. Williams, Oxford Univ. Press.
5. Tribology, Friction and Wear of Engineering Material, I. M.Hutchings, Edward Arnold, London.
6. Engineering Tribology, G. W. Stachowiak and A. W. Batchelor, Butterworth-Heinemann.
7. Engineering Tribology, P. Sahoo, PHI, New Delhi.
8. Terotechnology: Reliability Engineering and Maintenance Management, B Bhadury, S K Basu, Asian Books Pvt. Ltd.
9. Reliability Engineering and Terotechnology, A K Gupta, MacMillan India Limited

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



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Bachelor of Engineering (Part Time)

Subject Code: 3161918

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
10	10	30	40	10	05

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

Course Outcome:

After learning the course the students will able to:

Sr. No.	CO statement	Marks % weightage
CO-1	Summarized importance of tribology in industrial design and machine maintenance.	20
CO-2	Apply knowledge of friction and wear in design of machine components for better performance.	20
CO-3	Analyze different types of lubrication theory for machine components like bearings and gears.	40
CO-4	Assess different failure mode and maintenance methods as per terotechnology.	20

List of Experiments:

1. Determine the coefficient of friction for different conditions and different material pairs.
2. Experiments related to for wear measurement.
3. Experimental study on Journal bearing.
4. Exercises for design and tribological analysis of components subjected to relative motion.
5. Failure analysis of tribological compenents.

Major Equipment:

1. Universal tribometer.
2. Linear abrasive Wear test rig.
3. Pin-to-disc test rig.
4. Oil Journal Bearing Apparatus.

List of Open Source Software/learning website:

<https://nptel.ac.in/courses/112102014/> (as on 14th Feb, 2020)



GUJARAT TECHNOLOGICAL UNIVERSITY

Bachelor of Engineering

Subject Code: 3161919

Semester –VI

Subject Name: Energy Conservation and Management

Type of course: Applied Engineering

Prerequisite: Zeal to learn the subject and Basics of Environment Studies, Elements of Mechanical Engineering, Thermodynamics.

Rationale: The course is prepared to provide detailed understanding of energy conservation and management, 3Es (Energy, Economics and Environment) and their interaction, energy audit and financial management.

Teaching and Examination Scheme:

Teaching Scheme			Credits C	Examination Marks				Total Marks
L	T	P		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	% Weightage
1	Energy Scenario: Classification of Energy, Indian energy scenario, Sectorial energy consumption (domestic, industrial and other sectors), energy needs of growing economy, energy intensity, long term energy scenario, energy pricing, energy security, energy conservation and its importance, energy strategy for the future. Energy Conservation Act 2001 and related policies: Energy conservation Act 2001 and its features, notifications under the Act, Schemes of Bureau of Energy Efficiency (BEE) including Designated consumers, State Designated Agencies, Electricity Act 2003, Integrated energy policy, National action plan on climate change, ECBC code for Building Construction.	05	10
2	Financial Management, Energy Monitoring and Targeting: Investment-need, financial analysis techniques simple payback period, return on investment, net present value, internal rate of return, cash flows, risk and sensitivity analysis; financing options, energy performance contracts and role of Energy Service Companies (ESCOs) Energy Monitoring and Targeting: Defining monitoring & targeting, elements of monitoring & targeting, data and information-analysis, techniques – energy consumption, production, cumulative sum of differences (CUSUM). Energy Management Information Systems (EMIS)	06	15
3	Energy Management & Audit: Definition, energy audit, need, types of energy audit. Energy management (audit) approach-understanding energy costs, Bench marking, energy performance, matching energy use to requirement, maximizing system efficiencies, optimizing the input energy requirements, fuel and energy substitution, energy audit instruments and metering	05	15



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4	<p>Energy Efficiency in Thermal Utilities and systems:</p> <p>Boilers: Types, combustion in boilers, performances evaluation, analysis of losses, feed water treatment, blow down, energy conservation opportunities. Boiler efficiency calculation, evaporation ratio and efficiency for coal, oil and gas. Soot blowing and soot deposit reduction, reasons for boiler tube failures, start up, shut down and preservation.</p> <p>Steam System: Properties of steam, assessment of steam distribution losses, steam leakages, steam trapping, condensate and flash steam recovery system, identifying opportunities for energy savings. Steam utilization, Performance assessment of steam system, thermo-compressor, steam pipe insulation, condensate pumping, steam dryers.</p> <p>Furnaces: Classification, general fuel economy measures in furnaces, excess air, heat distribution, temperature control, draft control, waste heat recovery. Forging furnace heat balance, Cupola, non-ferrous melting, Induction furnace, performance evaluation of a furnace.</p> <p>Insulation and Refractories: Insulation-types and application, economic thickness of insulation, heat savings and application criteria, Refractory-types, selection and application of refractories, heat loss. Cold insulation.</p> <p>Heat Exchangers: Types, networking, pinch analysis, multiple effect evaporators, condensers, distillation column, etc.</p> <p>Waste Heat Recovery: Classification, advantages and applications, commercially viable waste heat recovery devices, saving potential.</p> <p>Cogeneration: Definition, need, application, advantages, classification, saving potentials. Heat balance, steam turbine efficiency, tri-generation, micro turbine.</p> <p>Heating, ventilation, air conditioning (HVAC) and Refrigeration System: Factors affecting Refrigeration and Air conditioning system performance and savings Opportunities. Vapor absorption refrigeration system: Working principle, types and comparison with vapor compression system and saving potential, heat pumps and their applications, section on ventilation system, and performance assessment of window and split room air conditioners and star labels.</p>	22	50
5	<p>Energy and environment, air pollution, climate change:</p> <p>United Nations Framework Convention on Climate Change (UNFCCC), sustainable development, Kyoto Protocol, Conference of Parties (COP), Clean Development Mechanism (CDM), CDM Procedures case of CDM – Bachat Lamp Yojna and industry; Prototype Carbon Fund (PCF).</p>	04	10

Suggested Specification table with Marks (Theory):

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
7	14	14	14	21	--

**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.



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Reference Books:

1. Energy Conservation Guidebook, Dale R Patrick, Stephen W Fardo, 2nd Edition, CRC Press
2. Handbook of Energy Audits, Albert Thumann, 6th Edition, The Fairmont Press.
3. Bureau of Energy Efficiency Reference book: No.1, 2, 3, 4.
4. Energy Management Handbook, W.C. Turner, John Wiley and Sons, A Wiley Interscience publication.
5. Carbon Capture and Sequestration: Integrating Technology, Monitoring, and Regulation edited by E J Wilson and D Gerard, Blackwell Publishing.
6. Heating and Cooling of Buildings - Design for Efficiency, J. Krieder and A. Rabl, McGraw Hill Publication, 1994.

Course Outcomes:

Sr. No.	CO statement	Marks % weightage
CO-1	To summarize the energy conservation scenario, energy and environment, air pollution, climate change, and various acts and policy for the energy conservation	20
CO-2	To infer the concept of financial management, energy monitoring and targeting.	10
CO-3	To apply the knowledge of energy audit for the energy management and operation of energy audit instruments.	15
CO-4	To analyze the energy saving area and improvement in efficiency of various thermal utilities and systems.	25
CO-5	To evaluate the net present worth in financial management and performance assessment of various thermal utilities and systems.	30

List of Experiments:

1. To study the various Acts and policy for the energy conservation.
2. To study the financial analysis techniques, energy performance contracts, role of energy service companies and evaluate net present worth for the finance.
3. To study the elements of energy monitoring and targeting, techniques, CUSUM and Energy Management Information Systems (EMIS).
4. To study and perform the use of energy audit instruments and prepare the energy audit report.
5. To study and performance evaluation, analysis of losses and energy saving opportunities for the boiler.
6. To study and performance evaluation, analysis of losses and energy saving opportunities for the steam system.
7. To study the types of insulation and refractories, economic thickness of insulation and selection criteria for the insulation and refractories.
8. To study and performance evaluation, analysis of losses and energy saving opportunities for the furnace.
9. To study and performance evaluation and energy saving opportunities for the window and split air-conditioner.
10. To study the framework for climate change, Kyoto Protocol, Conference of Parties (COP), Clean Development Mechanism (CDM), CDM Procedures and case of CDM



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List of Open Source Software/learning website:

1. <https://nptel.ac.in/courses/112/105/112105221>
2. <https://beeindia.gov.in>
3. www.powermin.nic.in
4. www.teriin.org
5. <https://geda.gujarat.gov.in>

GTUQuestionPapers.com



GUJARAT TECHNOLOGICAL UNIVERSITY

Bachelor of Engineering

Subject Code: 3161920

AUTOMOBILE ENGINEERING

SEMESTER: 6

Type of course: Undergraduate

Prerequisite: Basics of Mechanical Engineering, Physics, Environmental Sciences, Kinematics and Theory of Machines and Dynamics of Machinery,

Rationale: The aim is to introduce students to the vehicle structure and associated systems. Fundamentals related to vehicle and its systems' layouts, basic design of vehicle body structure and selection of systems components are introduced.

Teaching and Examination Scheme:

Teaching Scheme			Credits C	Examination Marks				Total Marks
L	T	P		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: Automobile classification and specification, Automobile chassis: General layout, types of layout and its arrangement, Body construction type and materials, Functional requirements of vehicle body, Body trim and fittings.	3
2	Road Load Analysis: Vehicle Loads: Forces acting on vehicle in motion, Transmission efficiency, Factors affecting it. Rolling resistance, Grade resistance, tractive force with uniform speed and with acceleration of vehicle, Traction characteristic. Dynamic factor, weight transfer due to various resistance acting on a vehicle in motion. Stability of a vehicle in motion around the curve.	6
3	Power Transmission systems: Clutch: Constructional features and working of single plate, multi plate, semi centrifugal and centrifugal clutch, Calculation of surface area and number of driving and driven plates. Transmission gear box: sliding mesh, constant mesh, synchromesh gearboxes and four wheel drive. Propeller shaft and Final drive: Propeller shaft, universal joints, Hotchkiss & Torque tube Drives, front drive shaft types and its construction and working, Differential gear box, rear axle. Automatic Transmission and CVT Fault and diagnosis of power transmission system.	10
4	Axle, Suspension and Steering System: Axle: Classification, types of front axle, Construction, Components and their functions, types of rear axle and application. Suspension: Principle, Types of suspension systems, Functional requirements of suspension systems, types and Constructional features of Front Suspension and Rear suspension system, Spring types, Rubber and Air suspensions, Factors affecting design and selection; Analysis of Suspension system: Mobility, kinematic/graphical analysis, Roll centre analysis and force analysis. Steering System: Steering Layout, types of steering gears, steering linkages, steering mechanism, definitions, and significance of camber, caster king, pin inclination, toe in and toe	8



GUJARAT TECHNOLOGICAL UNIVERSITY

Bachelor of Engineering

Subject Code: 3161920

	out on turn. Measurement and adjustment of various steering system layouts, steering ratio, under steering and over steering, power assisted steering, steering geometry, wheel alignment, and diagnosis of fault.	
5	Brake system: Components and configurations, Fundamentals of braking: braking distance, braking efficiency, weight transfer, wheel skidding, Brake proportioning and adhesion utilization, Hydraulic brake system, Power assisted brakes, ABS and EBD: Working principles, Features and advantages, Fault and diagnosis.	4
6	Wheel and Tyres: Types of wheels, types of tyres, tyre construction, constituents of tyre, tyre tread pattern, tyre pressure and wear, tyre properties, tyre size, tyre maintenance.	3
7	Electrical, Electronics and Safety systems: Engine control Unit, Monitoring and Instrumentation, Safety interlocks and alarms, Lamps, Lighting and other circuits, fuel gauge, temperature gauge, wiper, speedometer and odometer. Active and Passive Safety systems, Seat belt, Air bag, ACD, Electronic Stability Control (ESC), Tire Pressure Monitoring System (TPMS), Lane Departure Warning System (LDWS), Adaptive Cruise Control (ACC), Driver Monitoring System (DMS), Blind Spot Detection (BSD) and Night Vision System (NVS).	7
8	Modern Automobiles: Layout and components of Electric and Hybrid Vehicle, Types of Hybrid vehicles, Batteries, Electric Motors, Regenerative Braking.	4

A. List of Experiments

1. Study of different types of layout of Automobiles.
2. Study of different types of Transmission gearbox
3. Fault and diagnosis of power transmission system.
4. Study of constructional features of Front and rear suspension system.
5. Study of Hydraulic braking system.
6. Study of safety features of the automobile system.
7. Study of Electronic system of Automobiles.
8. Study of Hybrid vehicles.

Suggested Specification table with Marks (Theory):

Distribution of Theory Marks (%)					
R Level	U Level	A Level	N Level	E Level	C Level
25	35	35	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



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distribution of marks in the question paper may vary slightly from above table.

Course Outcomes: Students will be able to:

Sr. No.	CO statement	Marks % weightage
CO-1	Compare and select type of vehicle as per safety, features and applications.	7
CO-2	Evaluate vehicle performance for different driving and road conditions.	14
CO-3	Demonstrate working of various Automobile Systems	48
CO-4	Study of wheel and tyre, identify faults and diagnosis of automobile systems.	22
CO-5	Study of modern hybrid Automobiles	9

Major Equipment: Cut section of any four wheeler, cut section of various automobile systems

List of Open Source Software/learning website:

1. <http://nptel.ac.in>

Reference Books:

1. Automobile Engineering Vol- I & II by Dr. Kirpal Singh, Standard Pub.& Dist.
2. Automobile Engineering by R.B.Gupta , Satya Prakashan
3. Automobile Engineering Vol- I & II by Dr. K.M.Gupta,Umesh Pub.
4. Automobile Technology by Dr. N.K.Giri, Khanna Pub.
5. Automotive Mechanics by W.Crouse , Tata Mc Graw Hill
6. Automobile Engineering by G.B.S.Narang, Khanna Pub



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Subject Code: 3161921

Machine Tool Design

6th SEMESTER

Type of course: Departmental elective

Prerequisite: None

Rationale:

To develop comprehensive knowledge and understanding of working principles of machine tools. Students will be able to analyze the speed and feed regulation mechanisms of machine tools. Students will be able to design machine structures and guideways for better stability and precision.

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks				Total Marks
L	T	P		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 Machine Tool Drives: Types and capabilities of machine tools, Constructional and operational features, General Requirements of Machine Tool Design, Working and Auxiliary Motions in Machine Tools, Kinematics of Machine Tools, Motion Transmission, mechanical, hydraulic and electric drives.	03
2	Regulation of Speed and Feed Rates: Speed and Feed Regulation, Layout of Speed Change Gears, Saw Diagrams for Arithmetic, Geometric, Harmonic and Logarithmic Progression of spindle speeds. Establishment of Gear Ratios, Layout of the Intermediate Reduction Gears, Calculation of Transmission Ratios, Pulley Diameter, Gear Wheel Diameters and Number of Teeth. Ray Diagram. Speed Chart., Design of Speed Gear Boxes, Feed Drives, Feed Box Design.	10
3	Design of Machine Tool Structures: Functions of Machine Tool Structures and Their Requirements, Design criteria for Machine Tool Structures, Materials of Machine Tool Structures, Static and Dynamic Stiffness, Profiles of Machine Tool Structures, Basic Design Procedure of Machine Tool Structures, Design of Beds, Columns, saddles, carriages, Bases and Tables.	06
4	Design of Guideways and Power Screws : Functions and Types of Guide ways, Design of Slide ways, clearance adjustment in slideways. Design of Anti-Friction Guide ways, Combination Guide ways and Aerostatic guideways. Design of Power Screws and Recirculating ball screws	06
5	Design of Spindles and Spindle Supports: Functions of Spindles and Requirements, Effect of Machine Tool Compliance on Machining Accuracy, Design of Spindles, Antifriction Bearings.	05
6	Dynamics of Machine Tools: Machine Tool Elastic System, Static and Dynamic Stiffness, Effects of vibration, stability	05



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	analysis. Methods to reduce instability in machine tool like dampers, vibration absorbers, Machine Tool Chatter.	
7	Control Systems in Machine Tools: Machine tool control systems, Control Systems for Speed and Feed Changing, Adaptive Control Systems,	04
8	Ergonomics and aesthetic design of machine tool, Recent trends of machine tool.	03

Reference Books:

References:

1. Machine Tool Design and Numerical Control, N K Mehta, McGraw-Hill.
2. Machine Tool Design Handbook, Central Machine Tool Institute, McGraw-Hill
3. Design of Machine Tools, S.K. Basu, D K Pal, Oxford and IBH Publishing.
4. Principles of Machine Tools, G C Sen, A Bhattacharya, New Central Book Agency.

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	00

Course Outcome:

After learning the course the students will able to:

Sr. No.	CO statement	Marks % weightage
CO-1	Summarize principals of machine tool kinematics, motion transmission and control systems in machine tools.	20
CO-2	Examine various possible speed charts and select appropriate combination of gears to obtain various speeds and feeds in machine tools.	30
CO-3	Make use of machine design fundamentals to design the machine tool structure, guide ways and spindle.	40
CO-4	Evaluate effect of machine components' stiffness and dampers on machine tool vibration.	10



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List of Experiments:

1. Study of motion transmission mechanisms in various machine tools.
2. Design and drawing of gear box and feed box for speed and feed transmission.
3. Design and analysis of machine structures.
4. Vibration analysis of machine tools.
5. Design and drawing of machine spindles and its supports.
6. Control analysis of machine tools.

Major Equipment:

1. Mechanical Workshop.
2. Drawing hall

List of Open Source Software/learning website:

1. <http://nptel.ac.in>



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Bachelor of Engineering

Subject Code: 3161922

Advanced Manufacturing Processes

Semester VI

Type of course: Departmental elective

Prerequisite: Basic Knowledge of Manufacturing Processes

Rationale:

To impart comprehensive knowledge about consideration of manufacturing processes and metal removal rate during different advanced processes as well as product development processes.

Teaching and Examination Scheme:

Teaching Scheme			Credits C	Examination Marks				Total Marks
L	T	P		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	<p>Unconventional Machining Processes:</p> <p>Mechanical Energy Based Processes Abrasive Jet Machining (AJM), Water Jet Machining (WJM), Abrasive Water Jet Machining (AWJM), Ultrasonic Machining (USM). Working Principles – equipment used – Process parameters – MRR- Applications.</p> <p>Electrical Energy Based Processes Electric Discharge Machining (EDM)- working Principle- equipment used -Process Parameters - Surface Finish and MRR - electrode / Tool – Power and control Circuits-Tool Wear – Dielectric – Flushing – Wire cut EDM – Applications.</p> <p>Chemical and Electro-Chemical Energy Based Processes Chemical machining and Electro - Chemical machining (CHM and ECM) - Etchants – Maskant - techniques of applying maskants - Process Parameters – Surface finish and MRR - Applications. Principles of ECM - equipments-Surface Roughness and MRR Electrical circuit-Process Parameters- ECG and ECH - Applications.</p> <p>Thermal Energy Based Processes Laser Beam machining and drilling (LBM), Plasma Arc machining (PAM) and Electron Beam Machining (EBM). Principles – Equipment –Types - Beam control techniques – Applications.</p>	25
2	<p>Rapid Prototyping</p> <p>Introduction Stereo Lithography Systems Introduction: Need for the compression in product development, history of RP systems, Survey of applications, Growth of RP industry, and classification of RP systems. Stereo Lithography Systems: Principle, Process parameter, Process details, Data preparation, data files and machine details, Application.</p> <p>Selective Laser Sintering Fusion Deposition Modelling</p>	10



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	Selective Laser Sintering: Type of machine, Principle of operation, process parameters, Data preparation for SLS, Applications. Fusion Deposition Modelling: Principle, Process parameter, Path generation, Applications. Solid Ground Curing Principle of operation, Machine details, Applications. Laminated Object Manufacturing: Principle of operation, LOM materials. Process details, application. Concepts Modelers Principle, Thermal jet printer, Sander's model market, 3-D printer. Genisys Xs printer HP system 5, object Quadra systems.	
3	Glass Science Glass and Glassy State, Glass Compositions and Properties, Raw Materials, Glass Melting, glass furnace and furnace types, Glass Forming Processes, Glass processing, Application of Glass	5
4	Composite Materials Introduction, Classification of composites, Manufacturing methods : Spray Lay-Up, Wet/Hand Lay-up, Vacuum Bagging, Filament Winding, Pultrusion, Resin Transfer Moulding (RTM), Resin Film Infusion (RFI), Mechanical Properties -Stiffness and Strength	5

Reference Books:

1. Unconventional Machining process, Dr. Senthil, A R S Publishers
2. Modern Machining Processes, P. C. Pandey, H. S. Shan, Tata McGraw-Hill
3. Design for Advanced Manufacturing: Technologies and Processes, LaRoux K. Gillespie, McGraw-Hill Education
4. Advanced Machining Processes / Non Traditional and Hybrid Machining Processes, Hassan El-Hofy, McGraw-Hill
5. The Handbook of Glass Manufacture, F. Tooley, Tooley, New York : Books for Industry, [1974]
6. 3D Printing and Additive Manufacturing: Principles and Applications, Chee Kai Chua and Kah Fai Leong, World Scientific
7. Rapid Prototyping, Adithan M., Atlantic Publisher

Distribution of marks weightage for cognitive level

Bloom's Taxonomy for Cognitive Domain	Marks % weightage
Recall	10
Comprehension	10
Application	40
Analysis	20
Evaluate	20
Create	00



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Subject Code: 3161922

Course Outcome:

After learning the course the students will able to:

Sr. No.	CO statement	Marks % weightage
CO-1	Demonstrate the principles of advanced manufacturing processes.	20
CO-2	Distinguish various metal removing processes based on surface finish.	20
CO-3	Select appropriate advanced manufacturing Processes as per row materials and surface finish.	20
CO-4	Identify appropriate advanced material processing techniques for different requirements and applications.	20
CO-5	Compare different advance material processing techniques for industry applications.	20

List of Experiments:

1. Case Studies/ Brain storming for selection criteria for different manufacturing processes.
2. Case studies for cost estimation of various advanced manufacturing processes.
3. Case study of 3D Printing
4. Case study of design for advance machining processes.
- 5 Case study of Rapid Prototyping

Major Equipment:

1. Lathe Machine, Abrasive Jet Machining (AJM), Water Jet Machining (WJM), Abrasive Water Jet Machining (AWJM), Ultrasonic Machining (USM). Electric Discharge Machining (EDM), Chemical machining and Electro - Chemical machining (CHM and ECM), Laser Beam machining and drilling (LBM), Plasma Arc machining (PAM) and Electron Beam Machining (EBM)
2. 3D Printer

List of Open Source Software/learning website:

1. <http://nptel.ac.in>



GUJARAT TECHNOLOGICAL UNIVERSITY

Bachelor of Engineering

Subject Code: 3161923

Semester VI

NON DESTRUCTIVE TESTING

Type of course: Departmental elective

Prerequisite: Basic Knowledge of Material Science and Metallurgy

Rationale: To impart comprehensive knowledge about differentiate various defect types and select the appropriate NDT methods and their industrial applications..

Teaching and Examination Scheme:

Teaching Scheme			Credits C	Examination Marks				Total Marks
L	T	P		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: Fundamentals of and introduction to destructive and non-destructive testing. Scope and limitations of NDT, Visual examination methods, Different visual examination aids.	6
2	Dye penetrant Testing/ liquid penetrant testing: Principle, procedure, characteristics of penetrant, types of penetrants, penetrant testing materials, fluorescent penetrant testing method– sensitivity, application and limitations	6
3	Magnetic Particle Testing: Important terminologies related to magnetic properties of material, principle, magnetizing technique, procedure, equipment, fluorescent magnetic particle testing method, sensitivity, application and limitations	6
4	Ultrasonic Testing: Basic principles of sound propagation, types of sound waves, Principle of UT, methods of UT, their advantages and limitations, Piezoelectric Material, Various types of transducers/probe, Calibration methods, use of standard blocks, technique for normal beam inspection, flaw characterization technique, defects in welded products by UT, Thickness determination by ultrasonic method, Study of A, B and C scan presentations, advantage, limitations acoustic emission testing – principles of AET and techniques	8
5	Radiographic testing: X-ray and Gamma-Ray radiography, Their principles, methods of generation, Industrial radiography techniques, inspection techniques, applications, limitations, Types of films, screens and penetrameters. Interpretation of radiographs, Safety in industrial radiography.	8
6	Leak and pressure testing: Definition of leak and types, Principle, Various methods of pressure and leak testing, Application and limitation	4



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7	Eddy current testing: Principle, instrument , techniques, sensitivity, application, limitation Thermal methods of NDT	4
	Total	

Reference Books:

1. Practical Non-destructive Testing – Baldev Raj, T. Jayakumar & M. Thavasimuthu, Norosa Publishing House, New Delhi.
2. Treatise on Non-destructive testing, Vol. 1,2 & 3 Edited by Dr. E.G. Krishnadas Nair, NDT Centre, Hal, Bangalore
3. Non-destructive testing, Warren J. McGonagle, Gordon Breach, Science Publishers Ltd.
4. Ultrasonic Testing of Materials, J. Krautkramer & Herbert Krautkramer, Narosa Publishing House, New Delhi.
5. Non-destructive testing, R. Hatmshaw.
6. Ultrasonic Methods of Testing Materials, Leszek Filipezynski, Zdzislaw Pawlowski & Jerzywehr, Butterworths, London.

Distribution of marks weightage for cognitive level

Bloom's Taxonomy for Cognitive Domain	Marks % weightage
Recall	10
Comprehension	20
Application	40
Analysis	20
Evaluate	10
Create	-

Course Outcome:

After learning the course the students will able to:

Sr. No.	CO statement	Marks % weightage
CO-1	Demonstrate the concepts of non-destructive testing methods.	25
CO-2	Make use of different methods of nondestructive testing	40
CO-3	Inspect the leakages and pressure of cylinders.	15
CO-4	Estimate the types of defect and size of defects.	20

List of Experiments:

1. To study about need of Nondestructive testing (NDT).
2. To perform visual test for given sample using visual aid.
3. To perform Dye/Liquid Penetration Test for given sample with visible and fluorescent dye.
4. To study and perform Magnetic Particle test using different methods of magnetization.



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5. To study and perform Ultrasonic Test for weld sample.
6. To measure thickness using UT machine for given sample.
7. To study Radiographic Testing.
8. To study and perform Leak Testing.
9. To study of Eddy Current Test.
10. To study acoustic emission testing and thermography

Major Equipment:

1. Prod type Magnetic Particle testing machine
2. Yoke type Magnetic Particle testing machine
3. Digital Ultrasonic Flaw Detector
4. Model of Radiography for demonstration of RT

List of Open Source Software/learning website:

1. www.nptel.ac.in
2. www.nde-ed.org



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Bachelor of Engineering

Subject Code: 3161924

Semester –VI

Subject Name: Entrepreneurship and E-business

Type of Course: Elective

Prerequisite: Nil

Rationale:

Entrepreneurship and e-business subject is introduced with motive to develop entrepreneurial attitude in today's competitive environment. Further this subject creates awareness about adopted technologies in the business

Teaching and Examination Scheme:

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

Content:

Sr. No.	Content	Total Hours
1	Entrepreneurship: Concept, Knowledge and skills requirement; Characteristics of successful entrepreneurs; role of entrepreneurship in economic development; Entrepreneurship process; factors impacting emergence of entrepreneurship; managerial vs. entrepreneurial approach and emergence of entrepreneurship.	04
2	Starting the venture: Generating business idea–sources of new ideas, methods of generating ideas, creative problem solving, opportunity recognition; environmental scanning, competitor and industry analysis. Feasibility study: Market feasibility, Technical / operational feasibility, Financial feasibility; drawing business plan; preparing project report; presenting business plan to investors.	08
3	Functional plans: Marketing plan – marketing research for the new venture, steps in preparing marketing plan, contingency planning. Organizational plan - Form of ownership, designing organization structure, job design, manpower planning. Financial plan - cash budget, working capital, Performa income statement Performa cash flow, perform balance sheet, break even analysis.	06
4	Sources of finance and Legal Issues: Debtor equity financing, commercial banks, venture capital; financial institutions supporting entrepreneurs. Intellectual property rights patents, trademarks, copyrights, trade secrets, licensing, Franchising.	04
5	Overview of E – business and Collaborative Partnerships:	08



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Bachelor of Engineering

Subject Code: 3161924

	Concept of E-business, Business Success through adoption of technology, information management for business Initiatives, Performance improvement through e-business. Introduction to various collaborative partnerships, E-commerce: Sectors of e-commerce, B to C, B to B and C to C ecommerce, E-commerce success factors, clicks and Bricks in e-commerce, collaborative commerce. E-Marketplace, M-commerce, E-Government; Various E-business Models, Challenges of the E-Business Models, Globalization of E-business.	
6	Strategic Initiatives for Technology Customer Relationship Management The evolution of CRM, functional areas of CRM, contemporary trends - SRM, PRM AND ERM, Future Trends of CRM Enterprise Resource Planning Core and Extended ERP; components of ERP system; Benefits and Risks of ERP implementation	05
7	Business Technologies and Decision Support Systems Introduction to different business technologies: Cloud computing, and Artificial Intelligence. Business and Decision support, Components of DSS, Benefits, Geographic Information and Data Visualization Systems, Group Decision Support System.	05
8	Ethics Ethics and Information, Ethical Computer Use Policy, Information Privacy Policy, E-mail Privacy Policy, Internet Use Policy, Employee Monitoring Policies	05

Suggested Specification table with Marks (Theory):

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

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

Course Outcomes: Students will be able to:

Sr. No.	CO statement	Marks % weightage
CO-1	Distinguish Entrepreneur and Entrepreneurship starting and feasibility study.	20
CO-2	Demonstrate Entrepreneurship functional plan with source of finance and legal issues.	25
CO-3	Describe E business, collaborative partnership and strategic technology.	25
CO-4	Describe business technology and decision support system	15
CO-5	Understand importance of Ethics in Entrepreneurship and E business.	15

Reference Books:

1. Entrepreneurship (Fifth Edition 2002); Robert Hisrich, Michael Peters; Tata McGraw Hill Publication



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2. Entrepreneurship: New venture creation by David Holt, Prentice Hall of India Pvt. Ltd.
3. Business Driven Technology – Haag/Baltzan/Philips – Tata McGraw Hill Publication
4. Management of Information Technology – Carroll W. Frenzel and John C. Frenzel, Thomson Press
5. e-Business 2.0 Roadmap for Success by Dr. Ravi Kalakota, Marcia Robinson, Pearson Education
6. E-commerce – A Managerial Perspective- P. T. Joseph, Prentice Hall India Publications.

Term Work:

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

Major Equipment: Nil

List of Open Source Software/learning website:

1. www.nptel.ac.in/

GTUQuestionPapers.com



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Subject Code: 3161925

Semester – VI

Subject Name: Cyber Laws and Ethics

Type of course:

Prerequisite: Nil

Rationale:

This course explores technical, legal, and social issues related to cybercrimes, Laws Cyber Ethics. Cybercrime and laws is a broad term that includes offences where a computer may be the target, crimes where a computer may be a tool used in the commission of an existing offence, and crimes where a computer may play a subsidiary role such as offering evidence for the commission of an offence. It is also required to have knowledge of Cyber Ethics and its role and significance.

Teaching and Examination Scheme:

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

Content:

Sr. No.	Content	Total Hrs
1	Introduction to Cyber law: Evolution of computer Technology, emergence of cyber space. Cyber Jurisprudence, Jurisprudence and law, Doctrinal approach, Consensual approach, Real Approach, Cyber Ethics, Cyber Jurisdiction, Hierarchy of courts, Civil and criminal jurisdictions, Cyberspace-Web space, Web hosting and web Development agreement, Legal and Technological Significance of domain Names, Internet as a tool for global access.	08
2	Information Technology Act: Overview of IT Act, 2000, Amendments and Limitations of IT Act, Digital Signatures, Cryptographic Algorithm, Public Cryptography, Private Cryptography, Electronic Governance, Legal Recognition of Electronic Records, Legal Recognition of Digital Signature, Certifying Authorities, Cyber Crime and Offences, Network Service Providers Liability, Cyber Regulations Appellate Tribunal, Penalties and Adjudication.	10
3	Cyber law and Related Legislation: Patent Law, Trademark Law, Copyright, Software – Copyright or Patented, Domain Names and Copyright disputes, Electronic Data Base and its Protection, IT Act and Civil Procedure Code, IT Act and Criminal Procedural Code, Relevant Sections of Indian Evidence Act, Relevant Sections of Bankers Book Evidence Act, Relevant Sections of Indian Penal Code, Relevant Sections of Reserve Bank of India Act, Law Relating To Employees And Internet, Alternative Dispute Resolution , Online Dispute Resolution (ODR).	08
4	Electronic Business and legal issues:	09



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	Evolution and development in E-commerce, paper vs paper less contracts E-Commerce models- B2B, B2C, E security. Business, taxation, electronic payments, supply chain, EDI, E-markets, Emerging Trends.	
5	Cyber Ethics: The Importance of Cyber Law, Significance of cyber Ethics, Need for Cyber regulations and Ethics. Ethics in Information society, Introduction to Artificial Intelligence Ethics: Ethical Issues in AI and core Principles, Introduction to Block chain Ethics.	10
	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
20	25	25	20	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. Cyber Laws: Intellectual property & E Commerce, Security- Kumar K, dominant Publisher
2. Cyber Ethics 4.0, Christoph Stuckelberger, Pavan Duggal, by Globethic
3. Information Security policy & Implementation Issues, NIIT, PHI
4. Computers, Internet and New Technology Laws, Karnika Seth, Lexis Nexis Butterworths Wadhwa Nagpur.
5. Legal Dimensions of Cyber Space, Verma S, K, Mittal Raman, Indian Law Institute, New Delhi,
6. Cyber Law, Jonthan Rosenoer, Springer, New York, (1997).
7. The Information Technology Act, 2005: A Handbook, OUP Sudhir Naib., New York, (2011)
8. Information Technology Act, 2000, S. R. Bhansali., University Book House Pvt. Ltd., Jaipur (2003).
9. Cyber Crimes and Law Enforcement, Vasu Deva, Commonwealth Publishers, New Delhi, (2003).

Course Outcomes: Students will be able to:

Sr. No.	CO statement	Marks % weightage
CO-1	Understand Cyber laws	25
CO-2	Describe Information Technology act and Related Legislation.	25
CO-3	Demonstrate Electronic business and legal issues.	25
CO-4	Interpret Cyber Ethics.	25

Term Work:

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



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Subject Code: 3161926
Semester: VI
Subject Name: Industry 4.0

Type of Course: Elective

Prerequisite: Nil

Rationale: NA

Teaching and Examination Scheme:

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

Content:

Sr. No.	Content	Total Hours
1	Introduction to Industry 4.0: Introduction, core idea of Industry 4.0, origin concept of industry 4.0, Industry 4.0 production system, current state of industry 4.0, Technologies, How is India preparing for Industry 4.0	07
2	A Conceptual Framework for Industry 4.0: Introduction, Main Concepts and Components of Industry 4.0, State of Art, Supportive Technologies, Proposed Framework for Industry 4.0.	07
3	Technology Roadmap for Industry 4.0 : Introduction, Proposed Framework for Technology Roadmap, Strategy Phase, Strategy Phase, New Product and Process Development Phase.	07
4	Advances in Robotics in the Era of Industry 4.0: Introduction, Recent Technological Components of Robots- Advanced Sensor Technologies, Internet of Robotic Things, Cloud Robotics, and Cognitive Architecture for Cyber-Physical Robotics, Industrial Robotic Applications- Manufacturing, Maintenance and Assembly.	08
5	The Role of Augmented Reality in the Age of Industry 4.0: Introduction, AR Hardware and Software Technology, Industrial Applications of AR.	06
6	Obstacles and Framework Conditions for Industry 4.0 : Lack of A Digital Strategy alongside Resource Scarcity, Lack of standards and poor data security, Financing conditions, availability of skilled workers, comprehensive broadband infra- structure, state support, legal framework, protection of corporate data, liability, handling personal data.	07

Suggested Specification table with %Marks (Theory):

Distribution of Theory Marks%					
R Level	U Level	A Level	N Level	E Level	C Level



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10	20	25	25	10	10
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R: Remembrance; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create and above Levels (Revised Bloom's Taxonomy)

Course Outcomes: Students will be able to:

Sr. No.	CO statement	Marks % weightage
CO-1	Describe Industry 4.0 and scope for Indian Industry	20
CO-2	Demonstrate conceptual framework and road map of Industry 4.0	35
CO-3	Describe Robotic technology and Augmented reality for Industry 4.0	25
CO-4	Demonstrate obstacle and framework conditions for Industry 4.0	20

Reference Books:

1. Alp Ustundag and Emre Cevikcan, "Industry 4.0: Managing the Digital Transformation".
2. Bartodziej, Christoph Jan, "The Concept Industry 4.0".
3. Klaus Schwab, "The Fourth Industrial Revolution".
4. Christian Schröder, "The Challenges of Industry 4.0 for Small and Medium-sized Enterprises".

List of Open Source Software/learning website:

1. www.nptel.ac.in/