GUJARAT TECHNOLOGICAL UNIVERSITY

BRANCH NAME: Mechanical/Production/Manufacturing Engineering
SUBJECT NAME: Operations Research
SUBJECT CODE: 2171901
BE semester VII

Type of course: Core

Prerequisite: Nil

Rationale:
Operations Research now a day widely used in the area of decision making for the real life problems. Managers and decision makers get idea for optimizing and approximating industrial problems. They not only strive to devise appropriate measures for problem solving but also apply scientific techniques to monitor the organizations ongoing activities such as production mix, transportation, queuing, assignment, dynamic, Integer, goal and game problem.

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks						Total Marks
				Theory Marks			Practical Marks			
L	T	P	C	ESE (E)	PA (M)		PA (V)		PA (I)	
					PA	ALA	ESE	OEP		
3	2	0	5	70	20	10	20	10	20	150

L- Lectures; T- Tutorial/Teacher Guided Student Activity; P- Practical; C- Credit; ESE- End Semester Examination; PA- Progressive Assessment; OEP-Open Ended problem; AL-Active learning;

Learning Objectives:

1. To build concrete foundation for their core branch as a thinker, inter disciplinary thoughts
2. To educate students by covering different aspects of Operations Research.
3. To create strong problem solving skills as an engineer along with an understanding of the approach, methods and requirements of linear Programming Problem for a successful career in advancing technology.
4. To educate students to understand different Real Life problems in the Operations Research area.

Content:

Unit No.	Topic	Teaching Hours	Weightage
1	**Operations Research:** Origin of Operation Research, Historical Standpoint, Methodology, Different Phases, Characteristics, Scope and Application of Operations Research.	02	05%

2	**Linear Programming Problem:** Introduction, Requirement of LP, Basic Assumptions, Formulation of LP, General Statement of LP, Solution techniques of LP: Graphical Methods, Analytical Methods: Simplex, Big M and Two Phase, Sensitivity Analysis, Primal and Dual Problems, Economic Interpretation.	08	20%
3	**Transportation and Assignment:** Transportation Problems definition, Linear form, Solution methods: North west corner method, least cost method, Vogel's approximation method. Degeneracy in transportation, Modified Distribution method, Unbalanced problems and profit maximization problems. Transshipment Problems. Assignment Problems and Travelling sales man Problem.	06	15%
4	**Queuing Theory:** Basis of Queuing theory, elements of queuing theory, Kendall's Notation, Operating characteristics of a queuing system, Classification of Queuing models, Preliminary examples of M/M/1:∞/FCFA	05	10%
5	**Inventory Control:** Inventory classification, Different cost associated to Inventory, Economic order quantity, Inventory models with deterministic demands, ABC analysis.	04	08%
6	**Replacement theory:** Introduction, Replacement of capital equipment which depreciated with time, replacement by alternative equipment, Group and individual replacement policy.	03	08%
7	**Game Theory:** Introduction, Characteristics of Game Theory, Two Person, Zero sum games, Pure strategy. Dominance theory, Mixed strategies (2x2, mx2), Algebraic and graphical methods. .	04	10%
8	**Decision Theory:** Introduction, Decision under certainty, Decision under risk, Decision under uncertainty: Laplace criterion, MaxiMin criterion, MiniMax criterion, savage MiniMax regret criterion, hurwicz criterion, Decision tree.	04	08%
9	**Project Management:** Introduction to PERT and CPM, critical Path calculation, float calculation and its importance. Cost reduction by Crashing of activity.	06	16%
	Total Hours	**42**	**100%**

Suggested Specification table with Marks (Theory):

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

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

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

Reference Books:

1. Operations Research: An Introduction by Hamdy Taha, Pearson
2. Operations Research by A M Natarajan, P Balasubramani, A Tamilarasi, Pearson Education Inc
3. Operations Research by P Mariappan, Pearson
4. Operations Research by H N wagner, Prentice hall.
5. Optimization in Operations Research by Ronald Rardin, Pearson Education Inc.
6. Operations Research by R. Paneerselvam, Prentice Hall of India Pvt. Ltd.
7. Quantitative Techniques in Management by N D Vohra, Tata McGraw-Hill

Course Outcome:

After learning the course the students should be able to:

1. Students will be able to describe characteristics and scope of OR.
2. Students will be able to define and formulate mathematical problems.
3. Students will be able to select optimal problems solving techniques for a given problem using LP.
4. Students will be able to formulate and solve transportation, travelling sales man and transshipment problems.
5. Students will be able to formulate and solve optimization problems related to job/ work assignments.
6. Students will be able to demonstrate and solve simple models of Game theory.
7. Students will be able to evaluate optimum solution using dynamic programming for different applications.
8. Students will be able to choose / devise appropriate queuing model for practical application.
9. Students will be able to solve different problems related to Network.

List of Experiments:

1. Exercise on definition, formulation of linear programing problems.
2. Exercise on Graphical solution of linear programing problems
3. Exercise and case problems on Simplex, Big M and Two phase LP Problems
4. Exercise and case problems on Dual and Primal LP Problems
5. Exercise and case problems on Sensitivity Analysis
6. Exercise and case problems on Transportation and Transhipment Problems.
7. Exercise and case problems on Assignment and Travelling sales man Problems
8. Exercise and case problems on Queuing theory

9. Exercise and case problems on Game theory
10. Exercise on Inventory model
11. Exercise on Replacement theory
12. Exercise and case problems on PERT/CPM

Design based Problems (DP)/Open Ended Problem:

1. Industrial Problems of Linear Programming
2. Industrial Problems on Transportation
3. Industrial Problems on Assignment
4. Industrial Problems on Queuing
5. Industrial Problems on PERT and CPM

Major Equipment:

--

List of Open Source Software/learning website:

www.nptel.ac.in/

GUJARAT TECHNOLOGICAL UNIVERSITY

BRANCH NAME: Mechanical/Production/Manufacturing Engineering
SUBJECT NAME: Computer Aided Manufacturing
SUBJECT CODE: 2171903
BE semester VII

Type of course: Core

Prerequisite: Manufacturing Processes-I, Production 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	Examination Marks						Total Marks
				Theory Marks			Practical Marks			
L	T	P	C	ESE (E)	PA (M)		PA (V)		PA (I)	
					PA	ALA	ESE	OEP		
3	0	2	5	70	20	10	20	10	20	150

L- Lectures; T- Tutorial/Teacher Guided Student Activity; P- Practical; C- Credit; ESE- End Semester Examination; PA- Progressive Assessment; OEP-Open Ended problem; AL-Active learning;

Learning Objectives:

1. To build concrete foundation for their core branch as a thinker, inter disciplinary thoughts
2. To educate students by covering different aspects of computer Aided Manufacturing.
3. To create strong skills of writing CNC programs, PLC programs.
4. To educate students to understand different advances in manufacturing system like: GT, CAPP and FMS
5. To educate students by covering robotics and different material handling system required in manufacturing shop floor.
6. To educate students by covering different Integrated production management system.

Content:

Unit No.	Topic	Teaching Hours	Weightage
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	04	08%

	Manufacturing, Impact of CIM on personnel, Role of manufacturing engineers, CIM Wheel to understand basic functions.		
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 sub routines.	09	25%
3	**Programmable Logic Controllers:** Relay Device components, Programmable controller architecture, programming a programmable controller, tools for PLC logic design.	02	05%
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	12%
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, Flexible Fixturing, Flexible Assembly Systems.	07	20%
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	15%
7	**Integrated Production Management System:** Introduction, PPC fundamentals, Problems with PPC, MRP-I, MRP-II. Just in Time philosophy: JIT & GT applied to FMS, concepts of Expert System in Manufacturing and Management Information System.	07	15%
	Total Hours	**42**	**100%**

Suggested Specification table with Marks (Theory):

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

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

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

Reference Books:

1. 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
9. CAD/CAM, Principles and Applications –P N Rao, McGraw Hill, 2010
10. CAD/CAM, Introduction, -Ibrahim Zeid, Tata McGraw Hill, 2007

Course Outcome:

After learning the course the students should be able to:

1. Students will describe basic concepts of CAM application and understand CAM wheel
2. Students will prepare CNC programs for manufacturing of different geometries on milling and lathe machines.
3. Students will prepare logic diagram for different application of automation.
4. Students will classify different components using different techniques of group technology
5. Students will prepare Process planning for different components
6. Students will select layouts of FMS for industrial applications
7. Students will describe Robot for preliminary industrial applications like pick and place.
8. Student will identify application of PPC, JIT, MRP-I, MRP-II, and Expert system to CAM

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. Problems on MRP-I, MRP-II
10. Study of Expert System in Manufacturing and MIS

Design based Problems (DP)/Open Ended Problem:

1. Industrial case problems on CNC programming
2. PLC programming on simple cases
3. Case problems on GT and CAPP
4. Problems on Understanding of Kinematics of Robotics

Major Equipment:

1. CNC Machine
2. Industrial Robot
3. Programming Software.

List of Open Source Software/learning website:

www.nptel.ac.in/ Prentice

Videos on CNC programming, PLC, Robotics and FMS

GUJARAT TECHNOLOGICAL UNIVERSITY

BRANCH NAME: Mechanical Engineering
SUBJECT NAME: Machine Design
SUBJECT CODE: 2171909
B.E. 7th SEMESTER

Type of course: Under Graduate
Prerequisite: Machine Design and Industrial Drafting, Design of Machine Elements.
Rationale: The course aims to provide fundamental knowledge for analysis and design gear systems, Bearings, Internal Combustion engine components and cranes.

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks						Total Marks
				Theory Marks			Practical Marks			
L	T	P	C	ESE (E)	PA (M)		PA (V)		PA (I)	
					PA	ALA	ESE	OEP		
3	2	0	5	70	20	10	20	10	20	150

L- Lectures; T- Tutorial/Teacher Guided Student Activity; P- Practical; C- Credit; ESE- End Semester Examination; PA- Progressive Assessment; OEP-Open Ended problem; AL-Active learning;

Learning Objectives:

1. To introduce design considerations for various types of gears.
2. Learn design procedure for journal bearing selection of antifriction bearings.
3. Learn design of IC engine components and crane components.

Content:

Sr. No.	Content	Total Hrs	% Weightage
1	**Gear Design:** Recitation: Classification of gears, Selection of type of gears, Law of Gearing, Gear terminology, Standard system of gear tooth, force analysis, Interference and undercutting, number of teeth, gear tooth failures, selection of material. Spur and Helical Gears: Stress in gear tooth: Lewis formula, AGMA bending stress equation and AGMA pitting resistance formula, Gear quality and selection aspects. Bevel and Worm gears: Specifications and design of bevel and worm gears.	11	20
2	**Design of Gear Box for Machine Tools:** Comparison and Choice of progression (Arithmetic, Geometric, Harmonic and Logarithmic), general design procedure, determination and fixation of spindle speeds, selection of the best structure diagram, selection of gear layout and ray diagram, determination of number of teeth on gears.	5	10
3	**Journal Bearings:** Classification of bearings. Journal bearing Types, Lubrication: types of lubrication, Lubricants, Effect of pressure and temperature on viscosity, Stable lubrication, Thin and thick film lubrication. Hydraostatic Bearing: Viscous flow through rectangular slot, step bearing, energy losses. Hydrodynamic Bearing: Lubrication theory (Petroff's Equation, Reynolds' Equation), Design of bearings with Raimondi and Boyd method, power and heat generation, bearing materials.	7	18
4	**Rolling Contact Bearings:**	4	16

	Classification, Static load carrying capacity, Stribeck's equation, Dynamic load carrying capacity, Equivalent bearing load, Load-Life relation, Selection of bearing life, Load factor, Selection of bearing from catalogue, Design for cyclic loads and speeds, Bearing with probability of survival other than 90%, Selection of taper roller bearing, Bearing failure, Lubrication of rolling contact bearing.		
5	**IC Engine Components:** Design of cylinder and Cylinder head, Design of piston, Design of connecting rod, Design of crankshaft and Design of valve-gear mechanism.	9	20
6	**Design of Cranes:** Basic objectives of material handling system, Types of load, Classification and application of various Material handling equipment, Basic principles in selection of material handling system, Classification of cranes, Stress analysis and selection of Hooke (IS 15560, 2005), Pulley System (hoisting tackle analysis), Steel Wire ropes: Classification and coding, stress analysis and selection, Design of Sheave and drums.	8	16

Note: Use of Design data book should be permitted during the examination.

Suggested Specification table with Marks (Theory):

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

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

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

Reference Books:

1. R L Norton, Machine Design An Introduction, Pearson.
2. R G Budynas, and K J Nisbett, Shigley's Mechanical Engineering Design, McGraw-Hill
3. V B Bhandari, Design of Machine Elements, 3/e, McGraw Hill.
4. V B Bhandari, Machine Design Databook, McGraw Hill.
5. R C Juvinall, Fundamentals of Machine Component Design, 4/e, Wiley.
6. P C Gope, Machine Design: Fundamentals and Applications, 1/e PHI.
7. K Hoga, B Dondlinger, Vehicular Engine Design, Springer.

Course Outcome:

After learning the course the students should be able to:

- Design gears of various types.
- Design gearboxes for machine tools.
- Design journal bearing and select antifriction bearing for state application.
- Design IC engine components and crane parts.

List of Tutorials:

1. Design of Spur Gears.
2. Design of Helical Gears.
3. Design of Bevel Gear.
4. Design of Worm gear.
5. Design of Gearbox.
6. Design of Journal Bearing.
7. Selection of Rolling Contact bearing.
8. Design of IC engine components.
9. Design of Crane components.

Design based Problems (DP)/Open Ended Problem:

1. From the stated requirement of a machine tool, design a gearbox and gears for the same. Compare your design with the one available in machine tool and reason differences.
2. Design IC engine component and prepare a CAD model. Verify the kinematic performance of the assembly in CAD software.

Major Equipment:

Students may be exposed to following software/tools used for the design of various components.

1. http://www.mitcalc.com
2. http://www.kisssoft.ch/english/home/index.php
3. https://www.machinedesignonline.com/

List of Open Source Software/learning website:

1. www.nptel.ac.in/

GUJARAT TECHNOLOGICAL UNIVERSITY

BRANCH NAME: Mechanical Engineering
SUBJECT NAME: Power Plant Engineering
SUBJECT CODE: 2171910
B.E. 7th SEMESTER

Type of course: Applied Engineering
Prerequisite: Engineering Thermodynamics, Fluid Mechanics, Heat Transfer
Rationale: The course is designed to give fundamental knowledge of construction and working of various types of thermal power plants i.e. steam turbine, gas turbine, nuclear etc.

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks						Total Marks
L	T	P	C	Theory Marks			Practical Marks			
				ESE (E)	PA (M)		ESE (V)		PA (I)	
					PA	ALA	ESE	OEP		
4	0	2	6	70	20	10	20	10	20	150

L- Lectures; T- Tutorial/Teacher Guided Student Activity; P- Practical; C- Credit; ESE- End Semester Examination; PA- Progressive Assessment; OEP-Open Ended problem; AL-Active learning;

Content:

Sr. No.	Content	Total Hrs	% Weigh tage
1	**Thermal Power Plant:** General layout of modern thermal power plant, Site selection, Presents status of power generation in India	2	4
2	**High Pressure Boilers:** (Unique features and advantages of high pressure boilers, La-Mont; Benson; Velox, Loeffler and Schmidt-Hartmann boilers)*, supercritical boilers, Supercharged and fluidized bed combustion, Methods of superheat control, Corrosion in boilers and its prevention	4	7
3	**Coal and Ash Handling Systems:** Coal storage, Burning systems, Types of stokers and their working, Pulverized fuel handling systems, Unit and central systems, Pulverized mills- ball mill, Bowl mill, Ball & race mill, Impact or hammer mill, Pulverized coal burners, Oil burners, Necessity of ash disposal, mechanical; hydraulic; pneumatic and steam jet ash handling system, Dust collection and its disposal, Mechanical dust collector, Electrostatic precipitator	7	13
4	**Draught System:** Natural draught – estimation of height of chimney, Maximum discharge condition, Forced; induced and balanced draught, Power requirement by fans	3	5
5	**Steam Nozzles:** Types of nozzles, velocity of steam, discharge through nozzle, critical pressure ratio and condition for maximum discharge, physical significance of critical pressure ratio, nozzle efficiency	5	9
6	**Steam turbine:** (Principle of operation, types of steam turbines, compounding of steam turbines, impulse turbine – velocity diagram)*, calculation of work, power and efficiency, condition for maximum efficiency, Reaction turbines – velocity diagram, degree of reaction, reheat factor, (governing of steam turbine – throttle, nozzle and bypass governing)*, Methods of attachment of blades to turbine rotor, Labyrinth packing, Losses in steam turbine	7	13
7	**Condensers and Cooling Towers:** Types of condensers, sources of air in condenser, Effects of air leakage, Methods of obtaining maximum vacuum in condenser, vacuum & condenser efficiency, Mass of cooling water required,	6	10

	Edward air pump, Necessity of cooling ponds and cooling towers, Condenser water cooling systems, Types of cooling towers and cooling ponds		
8	**Feed Water Treatment:** Necessity of feed water treatment, Different impurities found in feed water, Effect of impurities, pH & its role in corrosion and scale formation, Internal & external water treatment systems – Hot lime soda process, Zeolite ion exchange process, Demineralization plants, Reverse osmosis process, Sea water treatment using reverse osmosis, De-aeration	5	9
9	**Gas turbine:** Classification, open and closed cycle, gas turbine fuels, actual Brayton cycle, optimum pressure ratio for maximum thermal efficiency, work ratio, air rate, effect of operating variables on the thermal efficiency and work ratio and air rate, combined steam and gas turbine plant, gas turbine blade cooling	8	14
10	**Nuclear Power Plant:** Nuclear fusion and fission, Chain reaction, Nuclear fuels, Components of nuclear reactor, Classification of reactors, Pressurized water reactor, Boiling water reactor, Gas cooled reactor, CANDU reactor, Fast breeder reactor, Nuclear waste and its disposal, Nuclear power plants in India	5	9
11	**Jet Propulsion:** Turbojet Engine*, thrust, thrust power, propulsive efficiency, thermal efficiency, (Turboprop, Ramjet and Pulsejet engines, Rocket engines)*	2	5
12	**Economics of Power Generation:** Load curves, Load duration curves, Connected load, Maximum load, Peak load, Base load and peak load power plants, Load factor, Plant capacity factor, Plant use factor, Demand factor, Diversity factor, Cost of power plant, Performance and operating characteristics of power plant, Tariff for electric energy	4	8

*** This topic should be covered during laboratory sessions**

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

Course Outcome:

After learning the course the students should be able to:

- Understand the different power generation methods, its economics and global energy situation
- Apply the basic thermodynamics and fluid flow principles to different power generation methods
- Analyze thermodynamic cycles of steam power plant and understand construction, working and significance of its various systems
- Analyze thermodynamic cycles of gas turbine power plant, nuclear power plant and jet propulsion systems

List of Experiments: (any ten experiments to be performed)

1. Study of Modern Steam Power Plant.
2. Study of Steam Turbines. (Impulse, Reaction and governing).
3. Study of Gas and Steam Turbine Combined Cycles.
4. Study of Nuclear Power Plant.
5. Study of various draught system.
6. Study of different feed water treatment plants.
7. Study of different types of steam nozzle and design a nozzle
8. Comparative study of different types of high pressure boilers
9. Study of Coal and Ash handling system.
10. Study of condenser and cooling tower.
11. Study of Jet Propulsion systems.

Design based Problems (DP)/Open Ended Problem:

1. Develop a working draught system.
2. Develop a working model of any water treatment system.
3. Develop a working model of cooling tower.

List of Open Source Software/learning website:

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

ACTIVE LEARNING ASSIGNMENTS: Preparation of power-point slides, which include videos, animations, pictures, graphics for better understanding theory and practical work – The faculty will allocate chapters/ parts of chapters to groups of students so that the entire syllabus to be covered. The power-point slides should be put up on the web-site of the College/ Institute, along with the names of the students of the group, the name of the faculty, Department and College on the first slide. The best three works should submit to GTU.

GUJARAT TECHNOLOGICAL UNIVERSITY

BRANCH NAME: Automobile Engineering (02) and Mechanical Engineering (19)
SUBJECT NAME: Vehicle Dynamics
SUBJECT CODE: 2170203
B.E. 7th SEMESTER

Type of course: Application

Prerequisite: ---

Rationale: To understand the principle and performance of vehicle in various modes such as longitudinal, vertical and lateral directions. At the end of the course the student will be able to identify the various forces and loads and performance under acceleration, ride and braking.

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks						Total Marks
L	T	P	C	Theory Marks			Practical Marks			
				ESE (E)	PA (M)		ESE (V)		PA (I)	
					PA	ALA	ESE	OEP		
3	0	2	5	70	20	10	20	10	20	150

Content:

Sr. No.	Content	Total Hrs	% Weightage
1	**Performance Characteristics of Vehicle:** SAE Vehicle axis system, Forces & moments affecting vehicle, Earth Fixed coordinate system, Dynamic axle loads, Equations of motion, transmission characteristics, vehicle performance, power limited and traction limited acceleration, braking performance, Brake proportioning, braking efficiency.	6	15
2	**Aerodynamics:** Mechanics of Air Flow Around a Vehicle, Pressure Distribution on a Vehicle, Aerodynamic Forces, Drag Components, Aerodynamics Aids.	4	10
3	**Tire Mechanics:** Tire Construction, Size and Load Rating, Terminology and Axis System, Tractive Properties, Cornering Properties, Camber Thrust, Aligning Moment, Combined Braking and Cornering, Conicity and Ply Steer, Slip, Skid, Rolling Resistance, Elastic Band Model for longitudinal slip, Simple model for lateral slip, Combined longitudinal/lateral slip (friction ellipse), Taut string model for lateral slip, Magic Tire Formula	7	15
4	**Suspensions:** Suspension Kinematics, Suspension types, Solid Axles, Independent Suspensions, Anti-Squat and Anti-Pitch Suspension Geometry, Anti-Dive Suspension Geometry, Roll Center Analysis, Suspension Dynamics, Multi-body vibration, Body and Wheel hop modes, Invariant points, Controllable Suspension Elements: Active, Semi-Active. Choice of	8	20

	suspension spring rate, Calculation of effective spring rate, Vehicle suspension in fore and apt directions.		
5	**The Steering System:** The Steering Linkages, Steering System Forces and Moments, Steering System Models, Steering Geometry, Steady Handling (2 DOF steady-state model), Understeer and Oversteer, Effect of Tire Camber and Vehicle Roll (3 DOF steady-state model), Transient Handling and Directional Stability (2 DOF unsteady model), Effect of Vehicle Roll on Transient Handling (3 DOF unsteady model), Steady-State and Transient Handling of Articulated Vehicles.	8	20
6	**Rollover:** Quasi-Static Rollover of a Rigid Vehicle, Quasi-Static Rollover of a Suspended Vehicle, Transient Rollover	4	10
7	**Motorcycle Dynamics:** Kinematic structure of motorcycle, geometry of motorcycles, importance of trail, Resistance forces acting on motorcycle (tyre rolling resistance, aerodynamic resistance forces, resistant force caused by slope), Location & height of motor cycle's centre of gravity (C.G), Moments of inertia on Motorcycle. Introduction to Front & Rear suspensions of Motorcycle.	5	10

Suggested Specification table with Marks (Theory):

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
10	10	15	20	10	5

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

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

Reference Books:

1. Hans Pacejka, Tire and Vehicle Dynamics, Elsevier, 2012.
2. Thomas D Gillespie, "Fundamentals of Vehicle dynamics", SAE USA 1992.
3. Rajesh Rajamani, Vehicle Dynamics & control, Springer.
4. R.V. Dukkipati, Vehicle dynamics, Narsova Publications.
5. Wong J Y, "Theory of Ground Vehicles", John Wiley & Sons, New York, 1978.
6. Milliken W F and Milliken D L, Race car Vehicle Dynamics, SAE.
7. Garrett T K, Newton K and Steeds W, "Motor Vehicle", Butter Worths & Co., Publishers Ltd., New Delhi, 2001.
8. Heinz Heister, "Vehicle and Engine Technology", SAE Second Edition, 1999.
9. Vittore Cossalter, Motorcycle Dynamics, 2nd Edition, Publisher: LULU.com
10. R N Jazar, Vehicle Dynamics: Theory and Application, Springer.

Course Outcome:

After learning the course the students should be able to:

- Understand the dynamics of vehicle ride

- Calculate and refer the loads and forces associated to the vehicles
- Analyse the behavior of the vehicles under acceleration, ride and braking

List of Experiments:

1. Experimental study of mechanism for air flow over different geometry of vehicles.
2. Experimental studies of measurements of drag and lift coefficient for different geometry vehicle using wind tunnel apparatus.
3. To study the effect of tyre pressure and temperature on the performance of the tyre.
4. To simulate and study a quarter car models using MBD (Multi Body Dynamics) software.
5. To simulate and understand behaviour of sprung / un-sprung mass & lumped mass system MBD software.
6. Finding the stiffness of tyre with variation of air pressure.
7. To simulate and study the effect of different conditions on vehicle loading.
8. Study of latest technologies available nowadays in vehicles helping to maintain stability of the vehicle on the road.
9. Study geometry of motorcycles as well as various types of forces faced by the motorcycle & its rider
10. Study the location & height of Centre of gravity (C.G) of a motorcycle

Design based Problems (DP)/Open Ended Problem:

- To design/check aerodynamics shapes of various car bodies, to calculate equivalent weight and maximum acceleration, desired power to propel the vehicle by CFD analysis.

Major Equipment:

- Wind tunnel apparatus
- Multibody (MBD) simulation software

List of Open Source Software/learning website:
http://nptel.ac.in/courses/107106080/

ACTIVE LEARNING ASSIGNMENTS: Preparation of power-point slides, which include videos, animations, pictures, graphics for better understanding theory and practical work – The faculty will allocate chapters/ parts of chapters to groups of students so that the entire syllabus to be covered. The power-point slides should be put up on the web-site of the College/ Institute, along with the names of the students of the group, the name of the faculty, Department and College on the first slide. The best three works should submit to GTU.

GUJARAT TECHNOLOGICAL UNIVERSITY

BRANCH NAME: Mechanical Engineering
SUBJECT NAME: Advance Heat Transfer
SUBJECT CODE: 2171911
B.E. 7th SEMESTER

Type of course: Elective
Prerequisite: Engineering Thermodynamics, Fluid Mechanics, Heat Transfer
Rationale: The course is prepared to provide the detailed understanding of conduction, convection, radiation and phase change. This course is design to learn techniques for heat transfer enhancement and usage of numerical methods for solving heat transfer problems.

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks						Total Marks
L	T	P	C	Theory Marks			Practical Marks			
				ESE (E)	PA (M)		ESE (V)		PA (I)	
					PA	ALA	ESE	OEP		
3	0	2	5	70	20	10	20	10	20	150

Content:

Sr. No.	Content	No. of Hrs.	% Weightage
1	**Heat conduction with heat generation:** Plane wall and cylinder with uniform heat generation, applications. Two-dimensional steady state conduction.	6	14
2	**Transient and multi dimensional heat conduction:** Exact solution, use of Heisler and Grober chart, integrated method	6	14
3	**Heat Transfer through extended surfaces:** Steady state analysis and optimization, radial fins of rectangular and hyperbolic profiles-longitudinal fin of rectangular profile radiating to free space.	7	17
4	**Convective Heat Transfer:** **Forced convection:** Introduction, heat transfer in high velocity flow, empirical relations for pipe and tube flow, flow across cylinders, spheres and tube banks, liquid-metal heat transfer **Natural Convection:** Introduction, empirical relations for free convection, free convection from vertical planes, cylinders, horizontal cylinders, horizontal plates, inclined surfaces, spheres and enclosed space, non-newtonian fluids, combined free and forced convection	10	19
5	**Convection with change of phase:** **Condensation:** Laminar film on a vertical surface, Turbulent film on a vertical surface, Film condensation in other configurations, Drop condensation, effect of non-condensable gases in condensing equipments **Boiling:** Pool boiling regimes, Nucleate boiling and peak heat flux, Film boiling and minimum heat flux, Flow boiling	6	17
6	**Radiation heat transfer:** Radiation effect on temperature measurements, radiation properties of a participating medium, emissivity and absorptivity of gases and gases mixtures, heat transfer from the human body, radiative exchange and overall heat transfer in furnaces.	8	19

Suggested Specification table with Marks (Theory):

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

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

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

Reference Books:

1. D.P. Incropera, P.P. and Dewitt, Fundamentals of Heat and Mass Transfer, Wiley Eastern
2. Adrian Bejan, Convective Heat Transfer, Wiley India.
3. Cengel Y A, Heat Transfer – A Practical Approach, McGraw Hill
4. Kays, Crawford and Weigand, Convective Heat and Mass Transfer, McGraw Hill.
5. Siegel and Howell, Thermal Radiation, McGraw Hill.
6. Kraus A.D., Aziz, A., and Welty, J., Extended Surface Heat Transfer, McGraw Hill
7. Adrian Bejan, Allan D. Krams, Heat Transfer Handbook, John Wiley & Sons.
8. J. P. Holman, Heat Transfer, McGraw Hill

Course Outcome:

After learning the course, the students should be able to:

- Develop ability to apply the basic principles of classical heat transfer in real engineering application
- Analyze the analytical and numerical solutions for heat transfer problem.
- Understand the basic concepts of turbulence and their impact on heat transfer

List of Experiments:

1. Experiment on "Heat transfer through composite wall at different temperature"
2. Experiment on "Thermal conductivity of insulating powder (Asbestos powder) "
3. Experiment on "Heat transfer in turbulent flow"
4. Experiment on "Heat transfer by forced convection"
5. Experiment on "Heat transfer coefficient in natural convection"
6. Experiment on "Heat transfer by radiation: Stefan-Boltzmann Law"
7. Experiment on "Thermal conductivity of metal rod "
8. Experiment on "Drop and Film wise condensation"
9. Experiment on "Unsteady state conduction heat transfer"

Design based Problems (DP)/Open Ended Problem:

1. Comparison of composite wall made of different materials
2. Calculate cooling capacity of domestic refrigerator
3. Calculate the effect of different fins in heat transfer

Major Equipment:

1. Conduction through Composite Wall
2. Heat Transfer in Natural convection
3. Heat Transfer in Forced Flow
4. Pin-Fin (Natural and Forced Convection)
5. Stefan Boltzmann Constant
6. Emissivity of test plate
7. Drop and Film wise condensation
8. Unsteady state conduction heat transfer

List of Open Source Software/learning website:

1. nptel.ac.in
2. www.learnerstv.com
3. cosmolearning.org

ACTIVE LEARNING ASSIGNMENTS: Preparation of power-point slides, which include videos, animations, pictures, graphics for better understanding theory and practical work – The faculty will allocate chapters/ parts of chapters to groups of students so that the entire syllabus to be covered. The power-point slides should be put up on the web-site of the College/ Institute, along with the names of the students of the group, the name of the faculty, Department and College on the first slide. The best three works should submit to GTU.

GUJARAT TECHNOLOGICAL UNIVERSITY

BRANCH NAME: Mechanical Engineering
SUBJECT NAME: Oil Hydraulics and Pneumatics
SUBJECT CODE: 2171912
B.E. 7th SEMESTER

Type of course: Elective
Prerequisite: None
Rationale: Course gives idea about the basic system working on fluid power and compressed air. Also different valves related to hydraulic and pneumatic systems are discussed in syllabus. Subject is also useful for designing the various hydraulic and pneumatic circuits for various engineering applications.

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks						Total Marks
L	T	P	C	Theory Marks		Practical Marks				
				ESE (E)	PA (M)	PA (V)		PA (I)		
						ESE	OEP	PA	RP	
3	0	2	5	70	30	20	10	10	10	150

L- Lectures; T- Tutorial/Teacher Guided Student Activity; P- Practical; C- Credit; ESE- End Semester Examination; PA- Progressive Assessment; OEP-Open Ended problem; AL-Active learning;

Content:

Sr. No.	Content	Total Hrs	% Weightage
1	**Introduction:** Introduction, Global fluid power Scenario, Basic system of Hydraulics-Major advantages and disadvantages, Principles of Hydraulic Fluid power, Hydraulic Symbols, Electrical Elements used in hydraulic circuits.	5	10
2	**System Components, Hydraulic Oils, Fluid Properties and Filter:** Hydraulic & Pneumatic Symbols as per ISO/ANSI, Types, Properties, physical characteristics & functions of hydraulic Oils, Classification- Mineral based, Fire resistant& Biodegradable Oils, Filters, Contaminations, location of filter.	5	15
3	**Hydraulic Pumps, Motors and Actuators:** Construction, working principle and operation of rotary & reciprocating pumps like Gear, Vane, Generated-Rotor, Screw, Axial Piston, Radial Piston, Pump characteristics, Linear and Rotary Actuators, Hydrostatic Transmission Systems. Selection of components for applications.	6	20
4	**Hydraulic Valves and Hydraulic System Accessories:** Direction control valves, Pressure control valves, Flow control valves, Non-return valves, Reservoirs, Accumulators, Heating & cooling devices, Hoses. Selection of valves for circuits.	6	18
5	**Design of hydraulic circuits:** Basic hydraulic circuits, Industrial hydraulic circuits, Power losses in flow control circuits.	6	10
6	**Introduction to Pneumatic Systems:** Basic Requirements for Pneumatic System, Applications, Pneumatic fundamentals, Construction, working principle and operation of pneumatic power transmission system components like Power source, FRL unit, Actuators and control valves like DCV, FCV, PCV, time delay, quick exhaust, twin pressure, shuttle.	6	12
7	**Pneumatic circuits:** Basic pneumatic circuits, Development of single Actuator Circuits, Development of multiple Actuator Circuits, Cascade method for sequencing.	6	10
8	Introduction to Automation in hydraulic and Pneumatic Systems.	3	5

Suggested Specification table with Marks (Theory):

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

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

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

Reference Books:

1. Industrial Hydraulics by John Pippenger and Tyler Hicks, McGraw Hill.
2. Oil Hydraulic Systems, Principle and Maintenance by S R Majumdar, McGraw-Hill.
3. Fluid Power with Applications by Anthony Esposito, Pearson.
4. Fluid Power: Generation, Transmission and Control, Jagadeesha T., Thammaiah Gowda, Wiley.
5. The Analysis & Design of Pneumatic Systems by B. W. Anderson, John Wiley.
6. Control of Fluid Power Analysis and Design by Mc Clay Donaldson, Ellis Horwood Ltd.
7. Hydraulic and Pneumatic Controls: Understanding made Easy, K.Shanmuga Sundaram, S.Chand & Co Book publishers, New Delhi, 2006 (Reprint 2009)
8. Basic Pneumatic Systems, Principle and Maintenance by S R Majumdar**,** McGraw-Hill.
9. Basic fluid power Dudley, A. Pease and John J. Pippenger, , Prentice Hall, 1987

Course Outcome:

After learning the course, the students should be able to:

1. Identify and analyse the functional requirements of a power transmission system for a given application. (Application involving fluid power transmission)
2. Design an appropriate hydraulic or pneumatic circuit or combination circuit like electro-hydraulics, electro-pneumatics for a given application. Develop a circuit diagram.
3. Visualize how the hydraulic/pneumatic circuit will work to accomplish the function.
4. Selection and sizing of components of the circuit.

List of Experiments:

A. Experiments on Hydraulics Circuits:

1. Extend-Retract and Stop system of a linear actuator.
2. Regenerative circuit.
3. Speed Control circuits: meter-in, meter-out and bleed off.
4. Sequencing circuit
5. Use of solenoid operated DCV.
6. Rapid Traverse and Feed circuit.

B. Experiments on Pneumatic Circuits:

1. Study of Compressor, FRL unit and 5/3 DCV.
2. Reciprocating motion of a single and a double acting actuators using 5/3 DCV.
3. Speed control circuits.
4. Automatic to & fro motion of a pneumatic linear actuator.
5. Sequencing circuit.
6. Logical circuits using shuttle valve.

C. Students should build up the above circuits on computer using software and simulate the flow of fluid during the operation. Afterwards, they themselves can physically connect the circuit on the hydraulic/pneumatic trainer and run the circuit.

Design based Problems (DP)/Open Ended Problem: Student can be given an application of a power transmission system for which they can evaluate the functional requirements and design appropriate circuit. They must identify the components, and relevant parameters. The application must involve use of hydraulics/pneumatics and/or combinations of different power transmission systems.

Major Equipment:

1. A hydraulic trainer
2. A pneumatic trainer
3. Simulation Software

List of Open Source Software/learning website:

1. Autosim Premium
2. Hydrosym

GUJARAT TECHNOLOGICAL UNIVERSITY

BRANCH NAME: Mechanical Engineering
SUBJECT NAME: Metal Forming Analysis
SUBJECT CODE: 2171913
B.E. 7th SEMESTER

Type of course: Engineering Science
Prerequisite: Zeal to learn the subject
Rationale:

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks						Total Marks
L	T	P	C	Theory Marks			Practical Marks			
				ESE (E)	PA (M)		ESE (V)		PA (I)	
					PA	ALA	ESE	OEP		
3	0	2	5	70	20	10	20	10	20	150

Content:

Sr. No.	Content	Total Hrs	% Weightage
1	Introduction to hot forming, cold forming, warm forming its advantages and disadvantages Typical stress strain diagram for ductile materials Forming properties of metals and alloys (yield strength/flow stress, ductility, strain hardening, strain rate sensitivity, effect of temperature and hydrostatic pressure on yield strength) Classification of forming processes and advantages of metal forming	02	5
2	Stress of stress at a point, stresses on an inclined plane, Principal stress, Two dimensional Mohr's circle for stress analysis, Deformation and strain, Stress of strain at a point	03	10
3	Yield conditions, Von Mises' hypothesis of yielding, Tresca's hypothesis of yielding, graphical representation of yield criteria, Elastic stress strain relations for isotropic elastic materials, Idealized stress strain relations in plastic deformations, Isotropic and kinematic work hardening	05	10
4	Introduction to; (i). Theory of slip lines, (ii). upper bound theorem and (iii). lower bound theorem	03	10
5	FORGING processes: Introduction, classification of forging, forging machines, metal flow in forging, Analysis of plane strain compression, analysis of compression of circular disc with slab method	06	15
6	EXTRUSION Processes: Introduction, calculation of extrusion load using slab method, slip line method & upper bound method. Defects in extrusion. Direct & indirect extrusion. WIRE DRAWING Processes: Introduction, defects, maximum possible reduction. Wire drawing load calculation using slab method.	08	15
7	ROLLING Processes: Classification, types of mill, Analysis of longitudinal strip or sheet rolling process (calculation of roll separating force, torque & power, angle of bite, maximum reduction in rolling), rolling defects, roll flattening, roll camber	06	15

8	SHEET METAL FORMING Processes: various sheet metal operations, Blanking and punching operations, compound and progressive dies, nesting, clearance, forces in blanking, Bending of plates, bendability, spring back, bending force, bending moment for real material, stress and strain in bending, stress in deep drawing, drawability. drawing load, Anisotropy in sheetmetal	10	15
9	Introduction to forming limit diagram, Friction and lubrication in forming processes	03	5

Suggested Specification table with Marks (Theory):

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

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

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

Reference Books:

1. Ghosh A. and Mallik A. K., "Manufacturing Science", East -West Press, New Delhi, 1998.
2. Juneja B. L., "Fundamentals of Metal Forming Processes", New Age International Publishers, 2010.
3. Hosford William F. and Caddell R. M., "Metal Forming Mechanics and Metallurgy", Prentice Hall, 1993.
4. Mielnik Edward M., "Metal Working Science and Engineering", McGraw Hill, 1991.
5. Dieter G. E., "Mechanical Metallurgy", McGraw Hill, 1988.
6. Rao P.N., "Manufacturing Technology", Tata McGraw Hill, 1990.
7. Wangoner Robert H. and Jean-Loup Chenot, "Fundamentals of Metal Forming", John Wiley & Sons, 1997.
8. Beddoes J. and Bibby M. J., "Principles of Metal Manufac turing Processes", Viva Books, 2000.
9. Sharma P. C., "Production Engineering", S. Chand & Co ., New Delhi, 2003.

Course Outcome:

After learning the course the students should be able to:

- Identify various forming process
- Identify and determine various methods rolling processes
- Identify and determine various methods to forging processes
- Identify and determine various methods to extraction processes
- Identify and determine various methods to Drawing processes
- Identify and determine various methods to Sheet metal forming processes

List of Experiments:

1. To construct a slip-line net for upsetting a work piece.
2. Experimental determination of stress strain behavior for ductile material and to evaluate the various elastic and plastic constants.
4. To analyze flow stress of the given material and to plot a graph of forging ratio vs. flow stress. Plot the bulge profile of the forged pieces, to find the radius of curvature of bulging of the forged pieces and to plot a graph of forging ratio vs. Hf / Rc.
5. To analyze the bending force vs. bending angle for 'V' bending of strip and to plot the strain distribution.

6. To measure the force required in extrusion of model material by using a die having different diameter and to draw the graphs between extrusion force vs. extrusion ratio.
7. To study the rolling process and plot the graph for percentage reduction in area vs. power in rolling.
8. Industrial visits for exposer to various metal forming process and report preparation based on observations and learning.

Design based Problems (DP)/Open Ended Problem:

1. Review of various methods for experimental measurements of friction in metal forming processes.
2. To plot the forming limit diagram and to study the effect of various strain paths on formability
3. To review research paper on experimental strain measurement in sheet metal forming processes

Major Equipment:

Various test setups can be developed over the period of time as UG project work or post graduate dissertations for performing experiments on related topics

List of Open Source Software/learning website:

1. Code_Aster
2. AutoForm
3. CalculiX
4. www.nptel.ac.in

ACTIVE LEARNING ASSIGNMENTS: Preparation of power-point slides, which include videos, animations, pictures, graphics for better understanding theory and practical work – The faculty will allocate chapters/ parts of chapters to groups of students so that the entire syllabus to be covered. The power-point slides should be put up on the web-site of the College/ Institute, along with the names of the students of the group, the name of the faculty, Department and College on the first slide. The best three works should submit to GTU.

GUJARAT TECHNOLOGICAL UNIVERSITY

BRANCH NAME: Mechanical Engineering
SUBJECT NAME: Gas Dynamics
SUBJECT CODE: 2171914
B.E. 7th SEMESTER

Type of course: Fundamental
Prerequisite: Fluid Mechanics
Rationale:

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks						Total Marks
L	T	P	C	Theory Marks			Practical Marks			
				ESE (E)	PA (M)		ESE (V)		PA (I)	
					PA	ALA	ESE	OEP		
3	2	0	5	70	20	10	30	0	20	150

L- Lectures; T- Tutorial/Teacher Guided Student Activity; P- Practical; C- Credit; ESE- End Semester Examination; PA- Progressive Assessment; OEP-Open Ended problem; AL-Active learning;

Content:

Sr. No.	Content	Total Hrs	% Weightage
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	19
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	10	24
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	22
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	19

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	16

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 Outcome:

After learning the course the students should be able to:

- Understand the basic concept of Gas Dynamics.
- Understand Behavior of Gas under various conditions.
- Use the Gas tables
- Understand basics of compressible flow
- Correlate fundamentals of Gas Dynamics with various mechanical systems

List of Experiments:

Design based Problems (DP)/Open Ended Problem:

Major Equipment:

List of Open Source Software/learning website:

1. http://nptel.ac.in/courses/112103021/
2. http://freevideolectures.com
3. www.learnerstv.com

ACTIVE LEARNING ASSIGNMENTS: Preparation of power-point slides, which include videos, animations, pictures, graphics for better understanding theory and practical work – The faculty will allocate chapters/ parts of chapters to groups of students so that the entire syllabus to be covered. The power-point slides should be put up on the web-site of the College/ Institute, along with the names of the students of the group, the name of the faculty, Department and College on the first slide. The best three works should submit to GTU.

GUJARAT TECHNOLOGICAL UNIVERSITY

BRANCH NAME: Mechanical Engineering
SUBJECT NAME: Applied Mechanics of Solids
SUBJECT CODE: 2171916
B.E. 7thSEMESTER

Type of course: Undergraduate

Prerequisite: Mechanics of Solids.

Rationale: The course is aimed give insight of techniques that can be used to predict the behavior of a solid that is subjected to mechanical loading.

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks						Total Marks
L	T	P	C	Theory Marks			Practical Marks			
				ESE (E)	PA (M)		ESE (V)		PA (I)	
					PA	ALA	ESE	OEP		
3	0	2	5	70	20	10	20	10	20	150

Content:

Sr. No.	Content	Total Hrs	% Weightage
1	State of stress: body and surface forces, traction vector and stress tensor, stress transformations, principle stresses, spherical and deviatoric stresses, equilibrium relations, Mohr's circle, Experimental techniques*	**9**	20 %
2	State of strain: general deformation, geometric construction of small deformation theory, strain transformations, principle strains, spherical and deviatoric strains, strain compatibility, Mohr's circle.	**7**	15 %
3	Stress function formulation: plane stress, plane strain, generalized plane stress, Airy stress function in Cartesian and polar coordinates.	**7**	15 %
4	Yield and failure criteria: yield criteria independent of hydrostatic pressure, failure criteria for pressure dependent materials.	**3**	5 %
5	Elastic stress strain relations: linear and nonlinear elastic isotropic stress strain relations, principle of virtual work, Drucker's stability postulate, Normality, convexity and uniqueness for an elastic solid, incremental stress strain relation.	**7**	15%
6	Stress strain relation for perfectly plastic materials: plastic potential and flow rule, flow rules associated with von Mises, Tresca and Mohr-Coulomb yield function, convexity, normality and uniqueness for elastic perfectly plastic materials, incremental stress strain relations, Prandti-	**5**	15 %

	Reuss and Drucker Prager material model,		
7	Stress strain relation for work hardening materials: deformation theory of plasticity, loading surface and hardening rules, Flow rule and Drucker's stability postulate, effective stress and effective strain	**5**	15

***Topics should be covered in only laboratory hours**

Suggested Specification table with Marks (Theory):

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
20	**30**	**15**	**15**	**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. Advanced Strength and Applied Stress Analysis, Richard G. Budynas, McGraw Hill
2. Advanced Mechanics of Materials and Applied Elasticity, A C Ugural and A K Fenster, Pearson
3. Theory of Elasticity, Timoshenko and Goodier, McGraw Hill.
4. Advanced Strength of Materials, Vol. 1, 2, Timoshenko, CBS
5. Experimental Stress Analysis, J W Dally & W F Riley, Mc Graw Hill
6. Elasticity, M. H. Sadd, Elsvier
7. Plasticity for Structural Engineers, W-F Chen and D-J Han, Cengage Learning
8. Advanced Mechanics of Solids, L S Srinath, Mc Graw Hill

Course Outcome:

After learning the course the students should be able to do the complete stress analysis on the basis of elastic and plastic limit of the material and these concepts can be directly apply to solve the industrial based design problem in detail.

List of Experiments:

1. Find the constitutive properties in elastic and plastic region for ductile soild using simple tension test.
2. Develop the code for measuring the stress concentration around a circular hole in a plate subjected to uniaxial loading using Airy's stress function approach.
3. Develop the code to predict the stress distribution in a wedge when subjected to various kind of loadings.
4. Study of strain gauge technique used for stress analysis.
5. Study of the photoelasticity approach.
6. Study of Coherent Gradient Sensing approach.
7. Study of digital image correlation technique.

Design based Problems (DP)/Open Ended Problem:

1. Stress analysis of circular disc under compression load using Airy stress function approach and compare the results using finite element analysis.
2. Design of thick vessel using plasticity concept.

Major Equipment:

1. Universal Testing Machine/Tensometer
2. Extensometer

List of Open Source Software/learning website:

1. Scilab and NPTEL lecture notes

ACTIVE LEARNING ASSIGNMENTS: Preparation of power-point slides, which include videos, animations, pictures, graphics for better understanding theory and practical work – The faculty will allocate chapters/ parts of chapters to groups of students so that the entire syllabus to be covered. The power-point slides should be put up on the web-site of the College/ Institute, along with the names of the students of the group, the name of the faculty, Department and College on the first slide. The best three works should submit to GTU.

GUJARAT TECHNOLOGICAL UNIVERSITY

BRANCH NAME: Mechanical Engineering (For Equivalency)
SUBJECT NAME: Steam and Gas Turbines
SUBJECT CODE: 2171917
B.E. 7th SEMESTER

Type of course: Applied Engineering

Prerequisite: Engineering Thermodynamics, Fluid Mechanics, Heat Transfer

Rationale: The course is designed to give fundamental knowledge of construction and working of various types of turbines and their components i.e. steam turbine, gas turbine, nozzles etc.

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks						Total Marks
L	T	P	C	Theory Marks			Practical Marks			
				ESE (E)	PA (M)		ESE (V)		PA (I)	
					PA	ALA	ESE	OEP		
3	0	0	3	70	20	10	0	0	0	100

Content:

Sr. No.	Content	Total Hrs	% Weightage
1	**Steam Nozzles:** Types of nozzles, velocity of steam, discharge through nozzle, critical pressure ratio and condition for maximum discharge, physical significance of critical pressure ratio, nozzle efficiency	8	20
2	**Steam Turbine**: Principle of operation, types of steam turbines, compounding of steam turbines, impulse turbine – velocity diagram, calculation of work, power and efficiency, condition for maximum efficiency, Reaction turbines – velocity diagram, degree of reaction, reheat factor, governing of steam turbine – throttle, nozzle and bypass governing, Methods of attachment of blades to turbine rotor, Labyrinth packing, Losses in steam turbine, Special types of steam turbine- back pressure, pass out and mixed pressure turbine.	14	33
3	**Gas Turbine:** Classification, open and closed cycle, gas turbine fuels, actual Brayton cycle, optimum pressure ratio for maximum thermal efficiency, work ratio, air rate, effect of operating variables on the thermal efficiency and work ratio, and air rate, simple open cycle turbine with regeneration, reheating and Intercooling, Combined steam and gas turbine plant, requirements of combustion chamber, types of combustion chambers.	14	33
4	**Jet Propulsion:** Fundamental of propulsion technology, Turbojet Engine, thrust, thrust power, propulsive efficiency, thermal efficiency, Turboprop, Ramjet and Pulsejet engines	6	14

Suggested Specification table with Marks (Theory):

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
05	15	20	15	10	05

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

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

Reference Books:

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

Course Outcome:

After learning the course the students should be able to:

- Analyse thermodynamic cycles of steam power plant and understand construction, working and significance of its various components
- Analyse thermodynamic cycles of gas turbine power plant and jet propulsion systems

List of Open Source Software/learning website:

http://nptel.ac.in/courses/112104117/18
http://nptel.ac.in/courses/112104117/4
http://nptel.ac.in/courses/112104117/17