GUJARAT TECHNOLOGICAL UNIVERSITY

Bachelor of Engineering (Part Time)
Subject Code: 2951914

GUJARAT TECHNOLOGICAL UNIVERSITY

MECHANICAL ENGINEERING (19)

TRIBOLOGY AND TEROTECHNOLOGY
SUBJECT CODE:
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	Examination Marks				Total Marks
L	T	P	C	Theory Marks		Practical Marks		
				ESE (E)	PA (M)	ESE (V)	PA (I)	
3	0	2	4	70	30	30	20	150

Content:

Sr. No.	Content	Total Hrs	% 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,	**06**	**12%**

	Lubricant supply in bearing, Design of journal bearings, Hydrodynamic thrust bearings, Fixed pad thrust bearing, Pressure Distribution, Tilting pad thrust bearing.		
4	**Hydrostatic and Squeeze Film Lubrication:** Hydrostatic Lubrication, Basic concept, Advantages and limitations, Viscous 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	**06**	**12%**
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 Terotechology:** 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

GUJARAT TECHNOLOGICAL UNIVERSITY

Bachelor of Engineering (Part Time)
Subject Code: 2951914

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	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)