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||Jai Sri Gurudev||

Sri Adichunchanagiri Shikshana Trust (R.)

SJC INSTITUTE OF TECHNOLOGY

An Autonomous Institution under VTU from 2024-25

AICTE Approved, Accredited by NAAC with A+ Grade & NBA (CSE, ISE, ECE, ME & CV), NIRF(151-300) in 2023,Gold Rated by QS I-Gauge

P.B. No.20, B.B Road, Chikkaballapur - 562 101, Karnataka

Estd : 1986

VII & VIII Semester
Scheme & Syllabus of B.E. Programme
Mechanical Engineering
(2024 Scheme)

Core Values

Spiritual, **J**udicious, **C**ommitment, **I**ntegrity, **T**rustworthy



NATIONAL INSTITUTIONAL RANKING FRAMEWORK 151-300

NAAC A+

QS I-GAUGE GOLD

INSTITUTION'S INNOVATION COUNCIL (Ministry of HRD Initiative) 4-Star Rating

SJC INSTITUTE OF TECHNOLOGY, CHIKKABALLAPURA

An Autonomous institution Under VTU from 2024 – 2025

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SCHEME OF TEACHING AND EXAMINATION – B.E. – Mechanical Engineering

(Applicable for students admitted from the Academic Year 2024-25 and onwards)

7th Semester

Mechanical Engineering												
Sl. No.	**Course Code**	**Course Title**	**Course Type**	**TD/ PSB**	**Teaching Hours / Week**			**Examination**				
					L	**T**	**P**	**SEE Duration (Hrs)**	**CIE Marks**	**SEE Marks**	**Total Marks**	**Credits**
1	BME701	Heat Transfer	IPCC	ME	3	0	2	**3**	**50**	**50**	**100**	**4**
2	BME702	Hydraulics and Pneumatics	IPCC	ME	3	0	2	**3**	**50**	**50**	**100**	**4**
3	BME703	Control Engineering	PCC	ME	3	2	0	**3**	**50**	**50**	**100**	**4**
4	BME724x	Professional Elective Course – IV	PEC	ME	3	0	0	**3**	**50**	**50**	**100**	**3**
5	BME745x	Open Elective Course – II	OEC	ME	3	0	0	**3**	**50**	**50**	**100**	**3**
6	BME736	Major Project Phase – II	PROJ	ME	0	0	12	**3**	**100**	**100**	**200**	**6**
7	BCR737	Career Readiness & Industry Integration	NCMC	CDCAC	0	2	0	**-**	**100**	**-**	**100**	**0**
									450	**350**	**800**	**24**

ASC: Applied Science Course, PCC: Professional Core Course, IPCC: Integrated Professional Core Course, PCCL: Professional Core Course laboratory, UHV: Universal Human Value Course, NCMC: Non Credit Mandatory Course, AEC: Ability Enhancement Course, SEC: Skill Enhancement Course, ESC: Engineering Science Course, ETC: Emerging Technology Course, PLC: Programming Language Course, L: Lecture, T: Tutorial, P: Practical, CIE: Continuous Internal Evaluation, SEE: Semester End Evaluation.

Professional Elective Course – IV

Course Code	Course Name	Course Code	Course Name
BME724A	Tribology	BME724C	IC Engines
BME724B	Operation Research	BME724D	Cryogenics

Open Elective Course – II

Course Code	Course Name	Course Code	Course Name
BME745A	Energy and Environment	BME745C	Basics of Hydraulics and Pneumatics
BME745B	Introduction to Non-Traditional Machining	BME745D	Non-Conventional Energy Resources

Professional Core Course (IPCC): Refers to Professional Core Course Theory Integrated with practicals of the same course. Credit for IPCC can be 04 and its Teaching– Learning hours (L : T : P) can be considered as (3 : 0 : 2) or (2 : 2 : 2). The theory part of the IPCC shall be evaluated both by CIE and SEE. The practical part shall be evaluated by only CIE (no SEE). However, questions from the practical part of IPCC shall be included in the SEE question paper. For more details, the regulation governing the Degree of Bachelor of Engineering (B.E.) 2024-25 may please be referred.

Professional Elective Courses (PEC): A professional elective (PEC) course is intended to enhance the depth and breadth of educational experience in the Engineering and Technology curriculum. Multidisciplinary courses that are added supplement the latest trend and advanced technology in the selected stream of engineering. Each group will provide an option to select one course. The minimum number of students' strengths for offering professional electives is 10. However, this conditional shall not be applicable to cases where the admission to the program is less than 10.

Open Elective Courses: Students belonging to a particular stream of Engineering and Technology are not entitled to the open electives offered by their parent Department. However, they can opt for an elective offered by other Departments, provided they satisfy the prerequisite condition if any. Registration to open electives shall be documented under the guidance of the Program Coordinator/ Advisor/Mentor. The minimum numbers of students' strength for offering Open Elective Course is 10. However, this condition shall not be applicable to class where the admission to the program is less than 10.

Project Work: The objective of the Project work is to:

i) Encourage independent learning and the innovative attitude of the students.
ii) Develop interactive attitude, communication skills, organization, time management, and presentation skills.
iii) Impart flexibility and adaptability.
iv) Inspire team working.
v) Expand intellectual capacity, credibility, judgment and intuition.
vi) Adhere to punctuality, setting and meeting deadlines.
vii) Install responsibilities to oneself and others.
viii) Train students to present the topic of project work in a seminar without any fear, face the audience confidently, enhance communication skills, involve in group discussion to present and exchange ideas.

CIE procedure for Project Work:

1) Single discipline: The CIE marks shall be awarded by a committee consisting of the Head of the concerned Department and two senior faculty members of the Department, one of whom shall be the Guide. The CIE marks awarded for the project work, shall be based on the evaluation of the project work Report, project presentation skill, and question and answer session in the ratio 50:25:25. The marks awarded for the project report shall be the same for all the batch mates.

2) Interdisciplinary: Continuous Internal Evaluation shall be group-wise at the college level with the participation of all guides of the college. Participation of external guide/s, if any, is desirable. The CIE marks awarded for the project work, shall be based on the evaluation of project work Report, project presentation skill, and question and answer session in the ratio 50:25:25. The marks awarded for the project report shall be the same for all the batch mates.

SEE procedure for Project Work: SEE for project work will be conducted by the two examiners appointed by the University. The SEE marks awarded for the project work shall be based on the evaluation of project work Report, project presentation skill, and question and answer session in the ratio 50:25:25.

Semester: VII						
Heat Transfer						
Course Code	**:**	**BME701**		**Credits**	**:**	03
Hours/Week(L:T:P)	**:**	3:0:2		**CIE**	**:**	50 Marks
Total Hours	**:**	40 hours Theory + 8-10 Lab slots		**SEE**	**:**	50 Marks
Course Type	**:**	IPCC		**SEE Duration**	**:**	3 Hours

Prerequisites:	
Courses	**NIL**
Knowledge on Fundamental Concepts	**NIL**
Knowledge on Connected Tools (If any)	**NIL**

Course Learning Objectives: This course will enable the students to	
CLO1	Principles of heat transfer.
CLO2	Steady and transient heat transfer, obtain the differential equation of heat conduction in various coordinate system.
CLO3	Physical mechanism of convection and visualize the development of velocity and thermal boundary layers during flow over a surface..
CLO4	The mechanisms of boiling and condensation and understand performance parameters of heat exchangers.
CL05	Radiation heat and mass transfer mechanisms

Module – 1	**08 Hrs**
Introductory Concepts and definition: Review of basics of Modes of Heat Transfer. **Conduction-Basic Equations:** General form of one-dimensional heat conduction equation. Boundary conditions of first, second and third kinds; **One dimensional Steady state conduction with and without heat generation:** Steady state conduction in slab, cylinder and sphere with engineering applications. **Steady state conduction:** Overall heat transfer coefficient for a composite medium; thermal contact resistance; critical thickness of insulation, Discussion on engineering applications. **Textbook-1: Chapter1,2 Textbook-2: Chapter 1**	
Module – 2	**08 Hrs**
Extended surfaces; Steady state conduction in fins of uniform cross section long fin, fin with insulated tip and fin with convection at the tip; fin efficiency & effectiveness, Discussion on engineering applications. **One dimensional Transient conduction**: Conduction in solids with negligible internal temperature gradients (lumped system analysis) Use of transient temperature charts (Heisler's charts) for Transient conduction in slab, long cylinder and sphere; Discussion on engineering applications. **Textbook-1: Chapter 3,4 Textbook-2: Chapter 2**	
Module – 3	**08 Hrs**
Concepts and Basic Relations in Boundary layers: Flow over a flat plate -Velocity	

boundary layer, Thermal boundary layer; Prandtl number; general expression for local heat transfer coefficient; Average heat transfer coefficient.

Forced Convection: Physical significance of Dimensionless numbers. Use of various Correlations for hydro dynamically and thermally developed flows; Use of correlations for flow over a flat plate, cylinder, sphere and flow inside the duct.

Free or Natural Convection: Physical significance of dimensionless numbers. Use of correlations for free convection from or to vertical, horizontal and inclined flat plates, vertical and inclined cylinder.

Textbook-1: Chapter 5,6 Textbook-3: Chapter 3

Module – 4	**08 Hrs**

Boiling and Condensation; Pool boiling regimes, Bubble growth mechanisms, Basics of Film and dropwise condensation, Use of correlations for film and dropwise condensation on tubes.

Heat Exchangers: Classification of heat exchangers; Overall heat transfer coefficient, Fouling, Scaling factors; LMTD and NTU methods of analysis of heat exchangers.

Textbook-1: Chapter 7,8 Textbook-3: Chapter 4

Module – 5	**08 Hrs**

Radiation Heat transfer: Review of basic laws of thermal radiation, Intensity of radiation and solid angle; Concept of thermal radiation resistance, Radiation network, view factor, Radiation heat exchange between two parallel infinite black surfaces, between two parallel infinite gray surfaces; Effect of radiation shield; Discussion on engineering applications.

Mass Transfer: Basic concepts- Diffusion mass transfer- Flick?s Law of diffusion- Steady state molecular diffusion- Convective mass transfer- Momentum, heat and mass transfer analogy- convective mass transfer correlations.

Textbook-1: Chapter 9,10 Textbook-2: Chapter5

PRACTICAL COMPONENT OF IPCC (May cover all / major modules)

Sl.NO	Experiments
1	Determination of Thermal Conductivity of a Metal Rod.
2	Determination of Overall Heat Transfer Coefficient of a Composite wall.
3	Determination of Effectiveness on a Metallic fin.
4	Determination of Heat Transfer Coefficient in free Convection
5	Determination of Heat Transfer Coefficient in a Forced Convention
6	Determination of Emissivity of a Surface and Determination of Stefan Boltzmann Constant.
7	Determination of LMDT and Effectiveness in a Parallel Flow and Counter Flow Heat Exchangers.
8	Experiments on Boiling of Liquid and Condensation of Vapour.
9	Experiment on Transient Conduction Heat Transfer.

Course Outcomes: After completing the course, the students will be able to	
CO1	**Determine** temperature distribution in steady state heat conduction.
CO2	**Apply** the heat transfer through extended surfaces and transient heat conduction.
CO3	**Interpret** and compute forced and free convective heat transfer
CO4	**Explain** the principles of radiation heat transfer and understand the numerical formula for heat conduction problems
CO5	**Design** of heat exchangers using LMTD, NTU methods and analyze the boiling and condensation.

Text Books	
1	Heat and mass transfer Kurt C, Rolle Cengage learning second edition
2	Heat Transfer A Basic Approach M. Necati Ozisik McGraw Hill, New York 2005
3	Fundamentals of Heat and Mass Transfer Incropera, F. P. and De Witt, D. P John Wiley and Sons, New York 5thEdition 2006
4	Heat Transfer Holman, J. P. Tata McGraw Hill, New York 9th Edition 2008

Web links and Video Lectures (e-Resources)	
1	https://www.youtube.com/watch?v=rxTK_SvSmvs&list=PL1gyM10tgL1hK9666oGndGlWDQdpQzkY9
2	https://www.kochheattransfer.com/products/twisted-tube-bundle-technology?gad=1&gclid=Cj0KCQjwmtGjBhDhARIsAEqfDEdG22TY7OHa8PBzHX1Yo_DKQcheV46aZxtD RvDIhCe1Gfpr5obDMLoaArSXEALw_wcB
3	https://www.hightemp-furnaces.com/

Activity Based Learning (Suggested Activities in Class)/ Practical Based learning	
1	Organize a visit to automobile service station and write a report for cooling systems in automobile.
2	Apply knowledge of plane wall transient conduction to determine the temperature distribution throughout the pizza as a function of time.

CO – PO MAPPING

COURSE OUTCOMES	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	3										2	2
CO2	3	3										2	2
CO3	3	3										2	3
CO4	3	3										2	1
CO5	3	3										2	1

Semester: VII						
Hydraulics & Pneumatics						
Course Code	**:**	**BME702**		**Credits**	**:**	03
Hours/Week(L:T:P)	**:**	3:0:2:0		**CIE**	**:**	50 Marks
Total Hours	**:**	40 hours Theory + 8-10 Lab slots		**SEE**	**:**	50 Marks
Course Type	**:**	IPCC		**SEE Duration**	**:**	3 Hours

Prerequisites:	
Courses	**NIL**
Knowledge on Fundamental Concepts	**NIL**
Knowledge on Connected Tools (If any)	**NIL**

Course Learning Objectives: This course will enable the students to	
CLO1	To provide an insight into the capabilities and applications of hydraulic and pneumatic fluid power.
CLO2	To understand concepts and relationships surrounding force, pressure, energy and power in fluid power systems.
CLO3	To examine concepts cantering on sources of hydraulic power, rotary and linear actuators, distribution systems, hydraulic flow in pipes, and control components in fluid power systems.
CLO4	Exposure to build and interpret hydraulic and pneumatic circuits related to industrial applications.
CLO5	To familiarize with logic controls and trouble shooting.

Module – 1	**08 Hrs**
Introduction to fluid power systems **Fluid power system**: components, advantages and applications. Transmission of power at static and dynamic states. Pascal's law and its applications. **Fluids for hydraulic system**: types, properties, and selection. Additives, effect of temperature and pressure on hydraulic fluid. Seals, sealing materials, compatibility of seal with fluids. Fluid conditioning through filters, strainers; sources of contamination and contamination control; heat exchangers. **Text Book-1: Ch 1, Text Book-2: Ch 1, Ch 2, Reference Book-2: Ch 1, Ch 2**	
Module – 2	**08 Hrs**
Pumps and Actuators **Pumps**: Classification of pumps, pumping theory of positive displacement pumps, construction and working of Gear pumps, Vane pumps, Piston pumps, fixed and variable displacement pumps, Pump performance characteristics, pump selection factors, problems on pumps. **Actuators**: Classification cylinder and hydraulic motors, Hydraulic cylinders, single and double acting cylinder, mounting arrangements, cushioning, special types of cylinders, problems on cylinders. Construction and working of rotary actuators such as gear, vane,	

piston motors, and Hydraulic Motor. Theoretical torque, power, flow rate, and hydraulic motor performance; numerical problems. Symbolic representation of hydraulic actuators (cylinders and motors).

Accumulators: Types, selection/ applications of accumulators

Text Book-1: Ch 2, Text Book-2: Ch 2, Ch 2, Reference Book-2: Ch 3, Ch 4

Module – 3	**08 Hrs**

Components and Hydraulic Circuit Design

Components: Classification of control valves, Directional Control Valves symbolic representation, constructional features of poppet, sliding spool, shuttle valve, and check valves.

Pressure control valves- types, direct operated types and pilot operated types.

Flow Control Valves -compensated and non-compensated FCV, needle valve, temperature compensated, pressure compensated, pressure and temperature compensated FCV, symbolic representation.

Hydraulic Circuit Design: Control of single and Double acting hydraulic cylinder, regenerative circuit, pump unloading circuit, double pump hydraulic system, counterbalance valve application, hydraulic cylinder sequencing circuits, cylinder synchronizing circuit using different methods, hydraulic circuit for force multiplication; speed control of hydraulic cylinder metering in, metering out. Hydraulic circuit examples with accumulator.

Text Book-1: Ch 3, Text Book-3: Ch 3, Ch 2, Reference Book-3: Ch 5, Ch 6

Module – 4	**08 Hrs**

Pneumatic Power Systems

Introduction to Pneumatic systems: Pneumatic power system, advantages, limitations, applications, Choice of working medium. Characteristics of compressed air and air compressors. Structure of pneumatic control System, fluid conditioners dryers and FRL unit.

Pneumatic Actuators: Linear cylinder – types of cylinders, working, end position cushioning, seals, mounting arrangements, and applications. Rotary cylinders types, construction and application, symbols.

Pneumatic Control Valves: DCV such as poppet, spool, suspended seat type slide valve, pressure control valves, flow control valves, types and construction, use of memory valve, Quick exhaust valve, time delay valve.

Text Book-1: Ch 4, Text Book-4: Ch 4

Module – 5	**08 Hrs**

Pneumatic Control Circuits

Simple Pneumatic Control: Direct and indirect actuation pneumatic cylinders, speed control of cylinders supply air throttling and exhaust air throttling.

Signal Processing Elements: Use of Logic gates OR and AND gates in pneumatic applications. Practical examples involving the use of logic gates.

Multi Cylinder Application: Coordinated and sequential motion control, motion and control diagrams. Signal elimination methods, Cascading method principle, Practical application examples (up to two cylinders) using cascading method (using reversing valves).

Text Book-1: Ch 5, Text Book-3: Ch 9,10

PRACTICAL COMPONENT OF IPCC (May cover all / major modules)

Sl No.	Experiments
1	A] Study of Construction and working Hydraulic pumps and Pneumatic B] Study of Hydraulic and Pneumatic valves. C] Study of solenoid valves, limit switches. Pressure, flow control valve
2	Basic hydraulic circuit for the working of double acting cylinder and a hydraulic motor
3	Basic pneumatic circuit for the working of single and double acting cylinder.

4	Speed control circuits. Different Metering methods Inlet & outlet flow control (meter in & meter out circuit)
5	Circuits for the Use of different direction control valves and valve actuation in single And double acting cylinder, and multi actuation circuit.
6	Hydraulic Counterbalancing circuit.
7	Hydraulic or Pneumatic Regenerative circuit.
8	Hydraulic or Pneumatic Sequencing circuit.
9	Can be Demo experiments for CIE Circuit with cam operated pilot valves operating a pilot operated 4way direction control Valve or proximity/ limit switches, solenoid operated 4way direction control valve for Auto reversing circuit.
10	Can be Demo experiments for CIE Study of hydraulics and Pneumatics circuit, based on the industrial application. (At least one in each)

Course Outcomes: After completing the course, the students will be able to	
CO1	**Explore** the basic concepts of fluid power systems, fluids types, properties and selection.
CO2	**Describe** the constructional features, details of pumps, motors, actuators and rectify the problems associated with pumps & motors.
CO3	**Evaluate** the applicability of servo systems & trouble shooting in fluid power systems.
CO4	**Design** appropriate hydraulic or pneumatic circuits for various applications.
CO5	**Develop** a comprehensive circuit diagram by integrating the components selected for the given application using signal processing element.

Text Books	
1	Anthony Esposito, “Fluid Power with applications”, Pearson edition, 2000.
2	Majumdar S.R., “Oil Hydraulics”, Tala McGRaw HllL, 2002.
3	Majumdar S.R., “Pneumatic systems Principles and Maintenance”, Tata McGrawHill, New Delhi, 2005

Reference Books	
1	John Pippenger, Tyler Hicks, “Industrial Hydraulics”, McGraw Hill International Edition, 1980.
2	Andrew Par, Hydraulics and pneumatics, Jaico Publishing House, 2005.
3	FESTO, Fundamentals of Pneumatics, Vol I, II and III.

Web links and Video Lectures (e-Resources)	
1	https://nptel.ac.in/courses/112105047/
2	https://www.youtube.com/watch?v=8xd7cWvMrvE
3	https://nptel.ac.in/courses/105103096/
4	https://nptel.ac.in/courses/112105047/37

Activity Based Learning (Suggested Activities in Class)/ Practical Based learning	
1	Quiz
2	Assignments/Presentations
3	Group Activity

CO – PO MAPPING

COURSE OUTCOMES	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	1	1									1	
CO2	3	2	2									1	
CO3	2	2	1		2							1	1
CO4	2	3	1		2							1	1
CO5	3	2	2		2							1	

Semester: VII						
CONTROL ENGINEERING						
Course Code	**:**	**BME703**		**Credits**	**:**	03
Hours/Week (L:T:P)	**:**	4:0:0		**CIE**	**:**	50 Marks
Total Hours	**:**	40		**SEE**	**:**	50 Marks
Course Type	**:**	PCC		**SEE Duration**	**:**	3 Hours

Prerequisites:	
Courses	**NIL**
Knowledge on Fundamental Concepts	**Laplace Transforms**
Knowledge on Connected Tools (If any)	**SCILAB**

Course Learning Objectives: This course will enable the students to	
CLO1	Modeling of Mechanical, Hydraulic, Pneumatic and Electrical systems.
CLO2	Representation of system elements by blocks and its Reduction
CLO3	Transient and steady state response analysis of a system.
CLO4	Frequency response analysis using root locus, Bode plots and Nyquist plots

Module – 1	**08 Hrs**
Introduction: Open loop and closed loop systems, Concepts of feedback, requirements of an ideal control system. **Types of controllers**-Proportional, Integral, Differential, Proportional & Integral, Proportional Differential and Proportional Integral Differential controllers. **Modeling of Physical Systems**: Mathematical Models of Mechanical, Electrical, Thermal, Hydraulic and Pneumatic Systems **Textbook-1: Chapter1,2 Textbook-2: Chapter 1**	
Module – 2	**08 Hrs**
Transient and Steady State Response Analysis: Introduction, test inputs**,** first order and second order system response to step, ramp and Impulse inputs. Concept of time constant and its importance in speed of response. Steady state error and error constants. **Textbook-1: Chapter 3 Textbook-2: Chapter 2**	
Module – 3	**08 Hrs**
Block diagram Algebra: General representation of a feedback control system, transfer functions, rules of block diagram algebra, reduction of block diagram to obtain closed loop transfer function. **Signal flow graphs:** Mason's gain formula. **System Compensation:** Series and Feedback Compensation, Lead Compensator, Lag Compensator. **Textbook-1: Chapter5,6 Textbook-2: Chapter 3,4**	
Module – 4	**08 Hrs**
Stability of linear control systems: Routh's stability criterion for a control system, **Root Locus Plots:** Root locus method, Significance of Root locus, angle and magnitude conditions, breakaway points, angles of departure and arrival, construction of Root locus using general rules and steps. **Textbook-1: Chapter 7 Textbook-3: Chapter 6**	

Module – 5	08 Hrs
Frequency Response Analysis: Relationship between time and frequency response, Polar plot, Bode's Plot, Nyquist plot and Nyquist stability criterion, Relative Stability, Phase and Gain Margins. **Textbook-1: Chapter 8 Textbook-3: Chapter 7**	

Course Outcomes: After completing the course, the students will be able to	
CO1	**Describe** the basic elements and structures of feedback control systems and also model the control basic systems.
CO2	**Estimate** the response and error in response of first and second order systems subjected standard input signals.
CO3	**Apply** Laplace transforms to determine the transfer functions for linear time invariant systems
CO4	**Analyse** a linear feedback control system for stability using Hurwitz criterion, Routh's criterion and root Locus technique in complex domain
CO5	**Analyse** the stability of linear feedback control systems in frequency domain using polar plots, Nyquist and Bode plots.

Text Books	
1	Modern control theory, Katsuhiko Ogata, Pearson Education International, Fifth edition.
2	J.Nagrath and M.Gopal," Control System Engineering", New Age International Publishers, 5th Edition, 2007
3	Control system engineering, Norman S Nise, John Wiley &Sons, Inc., Sixth edition
Web links and Video Lectures (e-Resources)	
1	https://onlinecourses.nptel.ac.in/noc22_ee31/preview
2	https://plccoep.vlabs.ac.in/exp/pidcontroller/index.html
Activity Based Learning (Suggested Activities in Class)/ Practical Based learning Frequency ❖ Frequency response of control system using MATLAB/SCILAB or any opensource software	

CO – PO MAPPING

COURSE OUTCOMES	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3												
CO2	3											3	
CO3	3	3	2									3	
CO4	3	3	2									3	
CO5	3	2	2									3	

Semester: VII						
Tribology						
Course Code	**:**	**BME724A**		**Credits**	**:**	03
Hours/Week(L:T:P)	**:**	3:0:0		**CIE**	**:**	50 Marks
Total Hours	**:**	40 hours Theory		**SEE**	**:**	50 Marks
Course Type	**:**	PEC		**SEE Duration**	**:**	3 Hours

Prerequisites:	
Courses	**NIL**
Knowledge on Fundamental Concepts	**NIL**
Knowledge on Connected Tools (If any)	**NIL**

Course Learning Objectives: This course will enable the students to	
CLO1	To understand the concepts of wear, friction and lubrication relative to rotary parts of machine.
CLO2	To explore the various mechanisms of pressure development and regimes of lubrication.
CLO3	To evaluate the performance of hydrodynamic bearings with and without leakage of lubricant.
CLO4	To expose the students to the factors influencing the selection of bearing materials for different sliding applications.
CLO5	To introduce the concepts of surface engineering and its importance in tribology.

Module – 1	**08 Hrs**
Introduction to Tribology-Historical background, practical importance, and subsequent use in the field of tribology. Properties of lubricants, viscosity, its measurement, effect of temperature and pressure on viscosity, lubrication types, standard grades of lubricants, and selection of lubricants. Types of lubricants. **Self-Study Component**: Specific field of lubricant applications. **Textbook-1: Chapter 1 Textbook-2: Chapter 1**	
Module – 2	**08 Hrs**
Friction and Wear Origin- friction theories, measurement methods, friction of metals and non-metals. Classification of wear, Mechanisms of wear, delamination theory, debris analysis, testing methods and standards. **Self-Study Component**: case studies related to friction and wear **Textbook-1: Chapter 2 Textbook-2: Chapter 2**	
Module – 3	**08 Hrs**
Bearing Materials- Commonly used bearings materials, and properties of typical bearing materials. Introduction to Surface engineering: Surface modification - transformation hardening, surface melting, thermo-chemical processes. Surface Coating - plating, fusion processes, vapor phase processes, Advantages and disadvantages of bearing materials. **Self-Study Component**: Selection of coating for wear and corrosion resistance. **Textbook-1: Chapter 3 Textbook-3: Chapter 3**	

Module – 4	08 Hrs
Hydrodynamic Journal Bearings-Friction forces and power loss in a lightly loaded journal bearing, Petroff's equation, mechanism of pressure development in an oil film, and Reynold's equation in 2D. Introduction to idealized journal bearing, load carrying capacity, condition for equilibrium, partial bearings, end leakages in journal bearing, numerical examples on full journal bearings only. **Self-Study Component**: Somerfield's number and its significance. **Textbook-1: Chapter 4 Textbook-2: Chapter 4 Textbook-3: Chapter 4**	
Module – 5	**08 Hrs**
Plane slider bearings- Derivation of expression for Pressure distribution and Load carrying capacity. (No derivation for coefficient of friction) frictional resistance in a fixed/pivoted shoe bearing, numerical examples. Hydrostatic Lubrication: Introduction to hydrostatic lubrication, hydrostatic step bearings, load carrying capacity and oil flow through the hydrostatic step bearing, numerical examples. End leakage effect. **Self-Study Component**: center of pressure **Textbook-1: Chapter 5 Textbook-2: Chapter 5 Textbook-3: Chapter 5**	

Course Outcomes: After completing the course, the students will be able to	
CO1	Describe the basic theories of friction, wear and lubrication to predict the frictional behavior between two surfaces which are in relative motion.
CO2	Develop mathematical relationship between the load carrying capacity, location of center of pressure and viscosity for hydrodynamic/journal bearing.
CO3	Examine the fundamental principles of hydrostatic bearings to determine the load carrying capacity and other related parameters in slider bearings.
CO4	Perform wear analysis using experimental/numerical test data
CO5	Elucidate the frictional resistance in slider bearings.

Text Books	
1	"Introduction to Tribology in bearings", B. C. Majumdar, Wheeler Publishing, 2010
2	"Engineering Tribology", Prasanta Sahoo, PHI Learning Private Ltd, New Delhi, 2011.
3	"Engineering Tribology", J. A. Williams, Oxford Univ. Press, 2005

Reference Books	
1	"Introduction to Tribology", B. Bhushan, John Wiley & Sons, Inc., New York, 2002.
2	"Handbook of tribology: materials, coatings and surface treatments", B.Bhushan, B.K. Gupta, McGraw-Hill, 1997.
3	"Engineering Tribology", G. W. Stachowiak and A. W. Batchelor, Butterworth-Heinemann, 1992

Web links and Video Lectures (e-Resources)	
1	NPTEL courses on Tribology

Activity Based Learning (Suggested Activities in Class)/ Practical Based learning	
1	Quiz
2	Assignment
3	Seminar presentation
4	Experimental/Numerical studies on wear of materials

CO – PO MAPPING

COURSE OUTCOMES	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2					1					
CO2	3	3	2	1								
CO3	3	3	2	1								
CO4	3	3	2	3	2		1					
CO5	3	2	1									

Semester: VII						
OPERATIONS RESEARCH						
Course Code	**:**	**BME724B**		**Credits**	**:**	03
Hours/Week(L:T:P)	**:**	3:0:0		**CIE**	**:**	50 Marks
Total Hours	**:**	40		**SEE**	**:**	50 Marks
Course Type	**:**	OEC		**SEE Duration**	**:**	3 Hours

Prerequisites:	
Courses	**NIL**
Knowledge on Fundamental Concepts	**NIL**
Knowledge on Connected Tools (If any)	**NIL**

Course Learning Objectives: This course will enable the students to	
CLO1	To introduce students to use quantitative methods and techniques for effective decisions– making.
CLO2	Mathematical model formulation and solving business decision problems.

Module – 1	**08 Hrs**
Introduction: Evolution of OR, definition of OR, scope of OR, application areas of OR, steps (phases) in OR study, characteristics and limitations of OR, models used in OR, linear programming (LP) problem-formulation and solution by graphical method. The simplex method using slack variables. **Textbook-1: Chapter1 Textbook-2: Chapter 1**	
Module – 2	**08 Hrs**
Transportation Problem: Formulation of transportation problem, types, initial basic feasible solution using different methods, optimal solution by MODI method, degeneracy in transportation problems, application of transportation problem concept for maximization cases. **Assignment Problem:** Formulation, types, application to maximization cases and travelling salesman problem. **Textbook-1: Chapter2 Textbook-3: Chapter 2**	
Module – 3	**08 Hrs**
PERT-CPM Techniques: Introduction, network construction - rules, Fulkerson's rule for numbering the events, AON and AOA diagrams; Critical path method to find the expected completion time of a project, floats; PERT for finding expected duration of an activity and project, determining the probability of completing a project, predicting the completion time of project; crashing of simple projects. **Textbook-1: Chapter3 Textbook-4: Chapter 3**	
Module – 4	**08 Hrs**

Game Theory: Formulation of games, types, solution of games with saddle point, graphical method of solving mixed strategy games, dominance rule for solving mixed strategy games.

Queuing Theory: Queuing systems and their characteristics, Pure-birth and Pure-death models (only equations), empirical queuing models (M/M/1 model).

Textbook-1: Chapter4 Textbook-2: Chapter 4

Module – 5	**08 Hrs**

Sequencing: Basic assumptions, sequencing 'n' jobs on single machine using priority rules, sequencing using Johnson's rule-'n' jobs on 2 machines, 'n' jobs on 3 machines, 'n' jobs on 'm' machines. Sequencing 2 jobs on 'm' machines using graphical method.

Textbook-1: Chapter5 Textbook-2: Chapter 5

Course Outcomes: After completing the course, the students will be able to	
CO1	Understand the importance, phases, & limitations of operations research.
CO2	Formulate a real-world problem in OR as a mathematical model.
CO3	Apply PERT and CPM network techniques to solve project management problems.
CO4	Choose appropriate OR models to solve transportation problem, assignment model,game theory, queuing theory and sequencing models.

Text Books	
1	**Operations Research**, P K Gupta and D S Hira, 7th Edition, Chand Publications, New Delhi
2	**Operations Researc**h, R. Panneerselvam, 3rd Edition, PHI
3	**Operations Research Theory, Methods & Applications**, S.D. Sharma, Kedarnath Ramanath & Co, 2012.
4	**Introduction to Operations Research**, Hillier and Lieberman, 8th Edn, McGraw Hill,

Web links and Video Lectures (e-Resources)	
1	https://nptel.ac.in/courses/112106134

Activity Based Learning (Suggested Activities in Class)/ Practical Based learning	
1	Use appropriate software tools to solve real world problems Operations Research for different businesses

CO – PO MAPPING

COURSE OUTCOMES	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	2	1		2		1					1		
CO2	3	3	2	2	1	1					2		
CO3	3	3	3	2	2				1	1	3		
CO4	3	3	3	2	2	1					2		

Course Outcomes: After completing the course, the students will be able to	
CO1	Understand the importance, phases, & limitations of operations research.
CO2	Formulate a real-world problem in OR as a mathematical model.
CO3	Apply PERT and CPM network techniques to solve project management problems.
CO4	Choose appropriate OR models to solve transportation problem, assignment model, game theory, queuing theory and sequencing models.

Text Books	
1	**Operations Research**, P K Gupta and D S Hira, 7th Edition, Chand Publications, New Delhi
2	**Operations Researc**h, R. Panneerselvam, 3rd Edition, PHI
3	**Operations Research Theory, Methods & Applications**, S.D. Sharma, Kedarnath Ramanath & Co, 2012.
4	**Operations Research**, A M Natarajan, P Balasubramani, Pearson Education, 2005
5	**Introduction to Operations Research**, Hillier and Lieberman, 8th Edn, McGraw Hill,

Web links and Video Lectures (e-Resources)	
1	https://nptel.ac.in/courses/112106134

Activity Based Learning (Suggested Activities in Class)/ Practical Based learning	
1	Use appropriate software tools to solve real world problems Operations Research for different businesses

CO – PO MAPPING

COURSE OUTCOMES	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	3	3									
CO2	3	3									
CO3	3	3									
CO4	3	3									
CO5	3	3									

Semester: VII						
IC Engines						
Course Code	**:**	**BME724C**		**Credits**	**:**	03
Hours/Week(L:T:P)	**:**	3:0:0		**CIE**	**:**	50 Marks
Total Hours	**:**	40 hours Theory + 8-10 Lab slots		**SEE**	**:**	50 Marks
Course Type	**:**	PEC		**SEE Duration**	**:**	3 Hours

Prerequisites:	
Courses	**NIL**
Knowledge on Fundamental Concepts	**NIL**
Knowledge on Connected Tools (If any)	**NIL**

Course Learning Objectives: This course will enable the students to	
CLO1	To give an overview of Internal Combustion Engines, their classification, applications, operation and processes.
CLO2	To describe combustion phenomena in IC engines.
CLO3	To give complete knowledge of type of fuels used in IC engines and the fuel supply systems.
CLO4	To explain the different performance analysis of IC engines.
CLO5	To explain the effects of exhaust emission on human health and various pollution norms.

Module – 1	**08 Hrs**
I.C. Engines- Classification based on multi cylinder engine, firing order, selection criteria of IC engines based on application, materials and manufacturing processes of ICE components. **Thermodynamic cycle analysis**– Deviation from ideal processes. Effect of chemical equilibrium and variable specific heats. Effect of air fuel ratio and exhaust gas dilution. Calculation of combustion temperatures. Use of combustion charts. Simple. numerical problems. **Textbook-1: Chapter 1 Reference book-1: Chapter 1**	
Module – 2	**08 Hrs**
Carburetion and combustion process in S.I. engines: Mixture requirements in S.I engine. Simple Carburetor and its limitations. Knock fee and knocking combustion Theories of combustion process in S.I. engines. Effect of Knock on engine performance. Effect of operating variables on knocking. Knock rating of fuels octane number. HUCR values. Anti-knock agents Pre ignition Post ignition. **Combustion in C.I. engines**: Ricardo's three stages of combustion process in C.I. engines. Delay period & factors affecting delay period. Diesel knock Methods of controlling diesel knock. Knock rating of Diesel fuels. **Textbook-1: Chapter 2 Reference book-2: Chapter 2**	
	08 Hrs

Module – 3	
Combustion chambers: Requirements of combustion chambers. Features of different types of combustion chambers system for S.I. engine. I head, F head combustion chambers. C.I. engine combustion chambers Air swirl turbulence M. type combustion chamber. Comparison of various types of combustion chambers. **Fuels**: Hydro carbons chemical structure influence of chemical structure on knock alternative fuels Alcohols vegetable oils Bio gas as Diesel engine fuels. **Textbook-1: Chapter 3 Reference book-2: Chapter 3**	
Module – 4	**08 Hrs**
Fuel injection systems: Diesel injection systems jerk pump injectors Nozzles of different types Petrol injection systems for S.I. engines Electronic fuel injection system. Cooling system Water cooling, air cooling & liquid cooling role of thermostats radiator construction. **Textbook-1: Chapter-4 Reference book-1: Chapter-4**	
Module – 5	**08 Hrs**
Modern developments: Turbo charging and super charging of I.C. Engines, Stratified charge engines (Lean burned SI engine) Multi fuel engines, Rotary piston engine, Two injector engines Pilot ignition engine, all ceramic swirl chamber engines. **Emission regulation and Control systems**: Mechanism of pollutant formation. Total emission control package thermal reactor package catalytic converter package control of NOX Exhaust gas recirculation Water injection. **Textbook-1: Chapter 5 Reference book-21: Chapter 5**	

Course Outcomes: After completing the course, the students will be able to	
CO1	Understand various types of I.C. Engines, Cycles of operation and Identify fuel metering, fuel supply systems for different types of engines.
CO2	Explain the operating characteristics and thermodynamic analysis of common internal combustion engine cycles.
CO3	Understand combustion phenomena in SI and CI engines and Analyze the effect of various operating variables on engine performance.
CO4	To analyze the combustion process of common fuels.
CO5	Function effectively as members of multidisciplinary teams.

Text Books	
1	Heywood J.B., “Internal combustion Engine Fundamentals”, McGraw Hill, 1988
2	Domkundwar V.M., “Internal combustion Engines”, 6th Ed.Tata McGraw Hill Publishing Co.
3	PulkrabekW , “Internal combustion engines”, 8thEd.; Dhanpat Rai publication.,2003,

Reference Books	
1	Ganesan V , “Internal combustion Engine and Air Pollution”, Intext Educational Pub,1974.
2	Ferguson and Kirkpatric; Internal Combustion Engines, by Wiley publishers.

Web links and Video Lectures (e-Resources)	
1	https://youtu.be/vIJ50aUiBgM
2	https://youtu.be/fTAUq6G9apg
3	https://youtu.be/_Ko0jJsQWxA
4	https://youtu.be/GR0oI5sDCww
5	https://youtu.be/sz8cqygvPC4
6	https://youtu.be/GWav5n1x6hQ

Activity Based Learning (Suggested Activities in Class)/ Practical Based learning	
1	Demonstration of IC engine
2	Overhauling of IC engine (assembling and disassembling of 4cylinder diesel jeep engine).
3	Emission test of IC engine vehicles.
4	Video demonstration of latest trends in IC engine.
5	Visit to nearest automotive sales and service shop.

CO – PO MAPPING

COURSE OUTCOMES	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	1				1	1						
CO2	3	3	2	2	1								
CO3	3	3	2	2		1	2						
CO4	3	3	2	2	1	1	2						
CO5								1	3	2	1		

Semester: VII						
Cryogenics						
Course Code	**:**	**BME724C**		**Credits**	**:**	03
Hours/Week(L:T:P)	**:**	3:0:0		**CIE**	**:**	50 Marks
Total Hours	**:**	40 hours Theory		**SEE**	**:**	50 Marks
Course Type	**:**	PEC		**SEE Duration**	**:**	3 Hours

Prerequisites:	
Courses	**NIL**
Knowledge on Fundamental Concepts	**NIL**
Knowledge on Connected Tools (If any)	**NIL**

Course Learning Objectives: This course will enable the students to	
CLO1	To understand cryogenic system and gas liquefaction system.
CLO2	To analyze gas cycle cryogenic refrigeration system.
CLO3	To Comprehend gas separation and gas purification system.
CLO4	To have detailed knowledge of vacuum technology, insulation, storage of cryogenic liquids.
CLO5	To study applications of cryogenics and to embark on cryogenic fluid.

Module – 1	**08 Hrs**
Introduction to Cryogenic Systems: Cryogenic propellants and its applications, liquid hydrogen, liquid nitrogen, and liquid Helium The Thermodynamically Ideal system Production of low temperatures – Joule Thompson Effect, Adiabatic expansion. Gas Liquefaction Systems: Liquefaction systems for Air Simple Linde –Hampson System, Claude System, Heylndt System, Dual pressure, Claude. Liquefaction cycle Kapitza System. Comparison of Liquefaction Cycles Liquefaction cycle for hydrogen, helium and Neon, Critical components of liquefaction systems. **Textbook-1: Chapter 1 Reference book-1: Chapter 1**	
Module – 2	**08 Hrs**
Gas Cycle Cryogenic Refrigeration Systems: Classification of Cryo coolers, Stirling cycle Cryo – refrigerators, Ideal cycle – working principle. Schmidt's analysis of Stirling cycle, Various configurations of Stirling cycle refrigerators, Integral piston Stirling Cryo cooler, Free displacer split type Stirling Cryo coolers, Gifford Mcmahon Cryo refrigerator, Pulse tube refrigerator, Solvay cycle refrigerator, Vuillimier refrigerator, Cryogenic regenerators. **Textbook-2: Chapter 2 Reference book-2: Chapter 2**	
Module – 3	**08 Hrs**
Gas Separation and Gas Purification Systems: Thermodynamic ideal separation system, Properties of mixtures, Principles of gas separation, Linde single column air separation. Linde double column air separation, Argon and Neon separation systems. Ultra Low Temperature Cryo–Refrigerators Magneto Caloric Refrigerator 3He4He Dilution refrigerator. Pomeranchuk	

cooling. Measurement systems for low temperatures, Temperature measurement at low temperatures, Resistance thermometers, Thermocouples, Thermistors, Gas Thermometry. Liquid level sensors.

Textbook-2: Chapter 3 Reference book-3: Chapter 3

Module – 4	**08 Hrs**

Vacuum Technology: Fundamental principles. Production of high vacuum, Mechanical vacuum pumps, Diffusion pumps, Cryo-pumping, Measurement of high vacuum level. Cryogenic Insulation: Heat transfer due to conduction, Evacuated porous insulation Powder & Fibers O pacified powder insulation, Gas filled powders & Fibrous materials Multilayer super insulation, Composite insulation

Textbook-1: Chapter 4 Reference book-3: Chapter 4

Module – 5	**08 Hrs**

Cryogenic Fluid Storage and Transfer Systems: Design of cryogenic fluid storage vessels, Inner vessel, Outer Insulation, Suspension system, Fill and drain lines. Cryogenic fluid transfer, External pressurization, Self-pressurization, Transfer pump. Application of Cryogenic Systems

Cryogenic application for food preservation – Instant Quick Freezing Techniques Super conductive devices, Cryogenic applications for space technology. Application of cryogenic systems, super conducting devices, space technology, cryogenic in biology and medicine.

Textbook-1: Chapter 5 Reference book-1: Chapter 5

Course Outcomes: After completing the course, the students will be able to	
CO1	Understand the cryogenic system.
CO2	Demonstrate the complete knowledge of cryogenic refrigeration system
CO3	Design gas separation and gas purification systems
CO4	Solve the problem in , insulation, storage of cryogenic liquids
CO5	Apply cryogenic in various areas and to be able take up research in cryogenics

Text Books	
1	Cryogenic Systems – R.F. Barron
2	Cryogenic Engineering – R.B. Scott – D.VanNostrand Company, 1959

Reference Books	
1	Cryogenic Process Engineering – K.D. Timmerhaus and T.M. Flynn, Plenum Press, New York,1989
2	High Vacuum Technology – A. Guthree – New Age International Publication
3	Experimental Techniques in Low Temperature Physics – G.K. White – Oxford University Press

Web links and Video Lectures (e-Resources)	
1	VTU E-learning.
2	NPTEL

Activity Based Learning (Suggested Activities in Class)/ Practical Based learning	
1	Quiz
2	Topic Seminar presentation
3	Assignments

CO – PO MAPPING

COURSE OUTCOMES	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	2											
CO2	3	2	1				1						
CO3	3	2	3	1			2						
CO4	3	3	2	1	1		1						
CO5	2	2		3		2	2						

Semester-VII						
ENERGY AND ENVIRONMENT						
Course Code	**:**	**BME745A**		**Credits**	**:**	03
Hours/Week(L:T:P)	**:**	3:0:0		**CIE**	**:**	50 Marks
Total Hours	**:**	40		**SEE**	**:**	50 Marks
Course Type	**:**	OEC		**SEE Duration**	**:**	3 Hours

Prerequisites:	
Courses	**Fundamentals of Mechanical Engineering**
Knowledge on Fundamental Concepts	**NIL**
Knowledge on Connected Tools (If any)	**NIL**

Course Learning Objectives: This course will enable the students to	
CLO1	To understand the fundamentals of energy sources, energy use, energy efficiency, and resulting environmental implications of various energy supplies.
CLO2	To introduce various aspects of environmental pollution and its control.
CLO3	To understand the causes and remedies related to social issues like global warming, ozone layer depletion, climate change etc.
CLO4	To introduce various acts related to prevention and control of pollution of water and air, forest protection act, wild life protection act etc.

Module – 1	**08 Hrs**
Basic Introduction to Energy: Energy and power, forms of energy, primary energy sources, energy flows, world energy production and consumption, Key energy trends in India: Demand, Electricity, Access to modern energy, Energy production and trade, Factors affecting India's energy development: Economy and demographics Policy. **Textbook-1: Chapter 1 Reference book-1: Chapter 1**	
Module – 2	**08 Hrs**
Energy storage systems: Thermal energy storage methods, Energy saving, Thermal energy storage systems Energy Management: Principles of Energy Management, Energy demand estimation, Energy pricing Energy Audit: Purpose, Methodology with respect to process Industries, Characteristic method employed in Certain Energy Intensive Industries. **Textbook-1: Chapter 2 Reference book-2: Chapter 2**	
Module – 3	**08 Hrs**

Environment: Introduction, Multidisciplinary nature of environmental studies- Definition, scope and importance, Need for public awareness. Ecosystem: Concept, Energy flow, Structure and function of an ecosystem. Food chains, food webs and ecological pyramids, Forest ecosystem, Grassland ecosystem, Desert ecosystem and Aquatic ecosystems, Ecological succession.
Textbook-1: Chapter 3 Reference book-1: Chapter 3

Module – 4	**08 Hrs**
Environmental Pollution: Definition, Cause, effects and control measures of - Air pollution, Water pollution, Soil pollution, Marine pollution, Noise pollution, Thermal pollution and Nuclear hazards, Solid waste Management, Disaster management Role of an individual in prevention of pollution, Pollution case studies. **Textbook-1: Chapter 4 Reference book-2: Chapter 4**	
Module – 5	**08 Hrs**
Social Issues and the Environment: Climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust. Case Studies. Wasteland reclamation, Consumerism and waste products, Environment Protection Act, Air (Prevention and Control of Pollution) Act, Water (Prevention and control of Pollution) Act, Wildlife Protection Act, Forest Conservation Act, Issues involved in enforcement of environmental legislation. **Textbook-1: Chapter 5 Reference book-1: Chapter 5**	

Course Outcomes: After completing the course, the students will be able to	
CO1	Understand energy scenario, energy sources and their utilization.
CO2	Understand various methods of energy storage, energy management and economic analysis.
CO3	Analyze the awareness about environment and eco system
CO4	Understand the environment pollution along with social issues and acts.

Text Books	
1	Textbook for Environmental Studies for Undergraduate Courses of all Branches of Higher Education, University grant commission and Bharathi Vidyapeeth Institute of environment education and Research, Pune
2	Energy Management Audit & Conservation- for Module 2, Barun Kumar De, Vrinda Publication, 2nd Edition 2010

Reference Books	
1	Energy Management Hand book, Turner, W. C., Doty, S. and Truner, W. C, Fairmont Press 7th Edition 2009
2	Energy Management, Murphy, W. R, Elsevier 2007

CO – PO MAPPING

COURSE OUTCOMES	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	1					1						

CO2	3	2	1				1						
CO3	3	3	3	2	1		2						
CO4	3	3	2	3	1	1	2	1					
CO5	3	2	2	3	2	2	2	1					

Semester: VII						
Introduction to Non-Traditional Machining						
Course Code	**:**	**BME745B**		**Credits**	**:**	03
Hours/Week(L:T:P)	**:**	3:0:0		**CIE**	**:**	50 Marks
Total Hours	**:**	40 hours Theory		**SEE**	**:**	50 Marks
Course Type	**:**	OEC		**SEE Duration**	**:**	3 Hours

Prerequisites:	
Courses	**NIL**
Knowledge on Fundamental Concepts	**NIL**
Knowledge on Connected Tools (If any)	**NIL**

Course Learning Objectives: This course will enable the students to	
CLO1	To appreciate the differences between conventional and nonconventional machining processes.
CLO2	To acquire a functional understanding of nontraditional manufacturing equipment.
CLO3	To know about various process parameters and their influence on performance and their applications.
CLO4	To impart knowledge on various types of energy involved in nontraditional machining processes.

Module – 1	**08 Hrs**
Introduction to Non-traditional machining, Need for Nontraditional machining process, Comparison between traditional and nontraditional machining, general classification Nontraditional machining processes, classification based on nature of energy employed in machining, selection of non-traditional machining processes, Specific advantages, limitations and applications of nontraditional machining processes. **Textbook-1: Chapter 1 Reference book-1: Chapter 1**	
Module – 2	**08 Hrs**
Ultrasonic Machining (USM): Introduction, Equipment and material process, Effect of process parameters: Effect of amplitude and frequency, Effect of abrasive grain diameter, effect of slurry, tool & work material. Process characteristics: Material removal rate, tool wear, accuracy, surface finish, applications, advantages & limitations of USM. **Abrasive Jet Machining (AJM):** Introduction, Equipment and process of material removal, process variables: carrier gas, type of abrasive, work material, standoff distance (SOD). Process Characteristics-Material removal rate, Nozzle wear, accuracy & surface finish. Applications, advantages & limitations of AJM. **Textbook-1: Chapter 2,4 Reference book-1: Chapter 2,3**	
Module – 3	**08 Hrs**
ELECTROCHEMICAL MACHINING (ECM): Introduction, Principle of electro chemical machining, ECM equipment, elements of ECM operation, Chemistry of ECM. ECM Process	

characteristics: Material removal rate, accuracy, surface finish. Process parameters: Current density, Tool feed rate, Gap between tool & work piece, velocity of electrolyte flow, type of electrolyte, its concentration temperature, and choice of electrolytes. ECM Tooling: ECM tooling technique & example, Tool & insulation materials. Applications ECM: Electrochemical grinding and electrochemical honing process. Advantages, disadvantages and application of ECG, ECH.

CHEMICAL MACHINING (CHM): Elements of the process, Resists (maskants), Etchants. Types of chemical machining process, chemical blanking process, chemical milling process. Process, characteristics of CHM: material removal rate, accuracy, surface finish, advantages, limitations and applications of chemical machining process.

Textbook-1: Chapter 4,5 Reference book-2: Chapter 4,5

Module – 4	**08 Hrs**

ELECTRICAL DISCHARGE MACHINING (EDM): Introduction, mechanism of metal removal, EDM equipment: spark erosion generator (relaxation type), dielectric medium-its functions & desirable properties, electrode feed control system. Flushing types; pressure flushing, suction flushing, side flushing, pulsed flushing.

EDM process parameters: Spark frequency, current & spark gap, surface finish, Heat Affected Zone. Advantages, limitations & applications of EDM, Electrical discharge grinding, Traveling wire EDM.

PLASMA ARC MACHINING (PAM): Introduction, non-thermal generation of plasma, equipment mechanism of metal removal, Plasma torch, process parameters, process characteristics. Safety precautions. Safety precautions, applications, advantages and limitations.

Textbook-1: Chapter 6,7 Reference book-1: Chapter 4,5

Module – 5	**08 Hrs**

LASER BEAM MACHINING (LBM): Introduction, generation of LASER, Equipment and mechanism of metal removal, LBM parameters and characteristics, Applications, Advantages & limitations.

ELECTRON BEAM MACHINING (EBM): Introduction, Principle, equipment and mechanism of metal removal, applications, advantages and limitations.

Textbook-1: Chapter 8,9 Reference book-1: Chapter 6

Course Outcomes: After completing the course, the students will be able to	
CO1	Understand the compare traditional and nontraditional machining process and recognize the need for Non-traditional machining process.
CO2	Explain the constructional features, performance parameters, process characteristics, applications, advantages and limitations of USM, AJM and WJM.
CO3	Identify the need of Chemical and electrochemical machining process along with the constructional features, process parameters, process characteristics, applications, advantages and limitations.
CO4	Understand the constructional feature of the equipment, process parameters, process characteristics, applications, advantages and limitations EDM & PAM.
CO5	Understand the LBM equipment, LBM parameters, and characteristics. EBM equipment and mechanism of metal removal, applications, advantages and limitations LBM & EBM.

Text Books	
1	Modern Machining Process by P.C Pandey and H S Shah, McGraw Hill Education India Pvt. Ltd. 2000
2	Production technology, HMT, McGraw Hill Education India Pvt. Ltd 2001

Reference Books	
1	New Technology, Dr. Amitabha Bhattacharyya, The Institute of Engineers (India) 2000
2	Modern Machining process, Aditya, 2002

Web links and Video Lectures (e-Resources)	
1	NPTEL course on NTM/ Modern manufacturing techniques
2	Videos on modern Manufacturing Techniques

Activity Based Learning (Suggested Activities in Class)/ Practical Based learning	
1	Quiz
2	Assignments/Presentations
3	Group Activity

CO – PO MAPPING

COURSE OUTCOMES	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	2	1		1	1	1					3	2
CO2	3	2	2	1	2	1	2					3	2
CO3	3	2	2	2	2	2	2					3	2
CO4	3	2	2	2	2	2	1					3	2
CO5	3	2	2	2	3	2	1					3	2

Semester: VII						
Basics of Hydraulics & Pneumatics						
Course Code	**:**	**BME745C**		**Credits**	**:**	03
Hours/Week(L:T:P)	**:**	3:0:0		**CIE**	**:**	50 Marks
Total Hours	**:**	40 hours Theory		**SEE**	**:**	50 Marks
Course Type	**:**	OEC		**SEE Duration**	**:**	3 Hours

Prerequisites:	
Courses	**NIL**
Knowledge on Fundamental Concepts	**NIL**
Knowledge on Connected Tools (If any)	**NIL**

Course Learning Objectives: This course will enable the students to	
CLO1	To provide an insight into the capabilities and applications of hydraulic and pneumatic fluid power.
CLO2	To understand concepts and relationships surrounding force, pressure, energy and power in fluid power systems.
CLO3	To examine concepts cantering on sources of hydraulic power, rotary and linear actuators, distribution systems, hydraulic flow in pipes, and control components in fluid power systems
CLO4	Exposure to build and interpret hydraulic and pneumatic circuits related to industrial applications.
CLO5	To familiarize with logic controls and trouble shooting

Module – 1	**08 Hrs**
Introduction to fluid power systems **Fluid power system**: components, advantages and applications. Transmission of power at static and dynamic states. Pascal's law and its applications. **Fluids for hydraulic system**: types, properties, and selection. Additives, effect of temperature and pressure on hydraulic fluid. Seals, sealing materials, compatibility of seal with fluids. Fluid conditioning through filters, strainers; sources of contamination and contamination control. **Textbook-1: Chapter 1 Reference book-1: Chapter 1**	
Module – 2	**08 Hrs**
Pumps and actuators **Pumps**: Classification of pumps, pumping theory of positive displacement pumps, construction and working of Gear pumps, Vane pumps, Piston pumps, fixed and variable displacement pumps, Pump performance characteristics, pump selection factors, **Actuators**: Classification cylinder and hydraulic motors, Hydraulic cylinders, single and double acting cylinder, cushioning, special types of cylinders, Construction and working of rotary actuators such as gear, vane, piston motors, and Hydraulic Motor. Symbolic representation of hydraulic actuators (cylinders and motors).	

Accumulators: Types, selection/ applications of accumulators.

Textbook-1: Chapter 2 Reference book-1: Chapter 2 Reference book-3: Chapter 2

Module – 3	**08 Hrs**

Components and hydraulic circuit design

Components: Classification of control valves, Directional Control Valves symbolic representation, constructional features of poppet, sliding spool, shuttle valve, and check valves.

Pressure control valves types- direct operated types and pilot operated types.

Flow Control Valves- compensated and non-compensated FCV, needle valve, temperature compensated, pressure compensated, pressure and temperature compensated FCV, symbolic representation.

Hydraulic Circuit Design: Control of single and Double acting hydraulic cylinder, regenerative circuit, 96 pump unloading circuit, double pump hydraulic system, counterbalance valve application, hydraulic cylinder sequencing circuits, cylinder synchronizing circuit using different methods, speed control of hydraulic cylinder metering in, metering out. Hydraulic circuit examples with accumulator.

Textbook-1: Chapter 3 Reference book-2: Chapter 3 Reference book-3: Chapter 3

Module – 4	**08 Hrs**

Pneumatic power systems

Introduction to Pneumatic systems: Pneumatic power system, advantages, limitations, applications, Choice of working medium. Characteristics of compressed air and air compressors. Structure of pneumatic control System, fluid conditioners, dryers and FRL unit.

Pneumatic Actuators: Linear cylinder – types of cylinders, working, end position cushioning, seals, mounting arrangements, and applications.

Pneumatic Control Valves: DCV such as poppet, spool, suspended seat type slide valve, pressure control valves, flow control valves, types and construction, use of memory valve, Quick exhaust valve, time delay valve.

Textbook-1: Chapter 4 Reference book-2: Chapter 4

Module – 5	**08 Hrs**

Pneumatic control circuits

Simple Pneumatic Control: Direct and indirect actuation pneumatic cylinders, speed control of cylinders supply air throttling and exhaust air throttling.

Signal Processing Elements: Use of Logic gates – OR, AND, NOT and NAND gates in pneumatic applications. Practical examples involving the use of logic gates.

Multi Cylinder Application: Coordinated and sequential motion control, motion and control diagrams. Signal elimination methods, Cascading method principle, Practical application examples (up to two cylinders).

Textbook-2: Chapter 5 Reference book-2: Chapter 5

Course Outcomes: After completing the course, the students will be able to	
CO1	Identify and analyse the functional requirements of a fluid power transmission system for a given application.
CO2	Understand the operation, application, and maintenance of common fluid power components such as pumps, actuators and accumulators.
CO3	Design an appropriate hydraulic or pneumatic circuit or combination circuit like electro hydraulics, electro pneumatics for a given application.
CO4	understand the pneumatic working media, applications and components of pneumatic

	system.
CO5	Develop a comprehensive circuit diagram by integrating the components selected for the given application using signal processing element.

Text Books	
1	Anthony Esposito, "Fluid Power with applications", Pearson edition, 2000.
2	Majumdar S.R., "Oil Hydraulics", Tala McGRaw HllL, 2002.
3	Majumdar S.R., "Pneumatic systems Principles and Maintenance", Tata McGrawHill, New Delhi, 2005

Reference Books	
1	John Pippenger, Tyler Hicks, "Industrial Hydraulics", McGraw Hill International Edition, 1980.
2	Andrew Par, Hydraulics and pneumatics, Jaico Publishing House, 2005.
3	FESTO, Fundamentals of Pneumatics, Vol I, II and III.

Web links and Video Lectures (e-Resources)	
1	https://nptel.ac.in/courses/112105047/
2	https://www.youtube.com/watch?v=8xd7cWvMrvE
3	https://nptel.ac.in/courses/105103096/
4	https://nptel.ac.in/courses/112105047/37

Activity Based Learning (Suggested Activities in Class)/ Practical Based learning	
1	Quiz
2	Assignments/Presentations
3	Group Activity

CO – PO MAPPING

COURSE OUTCOMES	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	3	2	1		1							
CO2	3	2	1		2	1	1						
CO3	3	3	2	2		1	1		1	1			
CO4	3	1	1		2	1	2						
CO5	3	2	3	2	2	1			1	1			

Semester-VII						
Non- Conventional Energy resources						
Course Code	**:**	**BME745D**		**Credits**	**:**	03
Hours/Week(L:T:P)	**:**	3:0:0		**CIE**	**:**	50 Marks
Total Hours	**:**	40		**SEE**	**:**	50 Marks
Course Type	**:**	OEC		**SEE Duration**	**:**	3 Hours

Prerequisites:	
Courses	**Fundamentals of Mechanical Engineering**
Knowledge on Fundamental Concepts	**NIL**
Knowledge on Connected Tools (If any)	**NIL**

Course Learning Objectives: This course will enable the students to	
CLO1	To introduce the concepts of solar energy, its radiation, collection, storage and application
CLO2	To introduce the concepts and applications of Wind energy, Biomass energy, Geothermal energy and Ocean energy as alternative energy sources.
CLO3	To explore society's present needs and future energy demands.
CLO4	To examine energy sources and systems, including fossil fuels and nuclear energy, and then focus on alternate, renewable energy sources such as solar, biomass (conversions), wind power, geothermal, etc.
CLO5	To get exposed to energy conservation methods.

Module – 1	**08 Hrs**
Introduction to Renewable Energy: Overview of global energy demand and the need for renewable energy, Comparison of renewable and non-renewable energy sources, Environmental benefits and challenges of renewable energy. **Solar Radiation**: Extra-Terrestrial radiation, spectral distribution of extra-terrestrial radiation, solar constant, solar radiation at the earth's surface, beam,diffuse and global radiation **Textbook-1: Chapter 1,2 Textbook-2: Chapter 1,2**	
Module – 2	**08 Hrs**
Solar Power Plants: **Measurement of Solar Radiation**: Pyrometer, shading ring pyrheliometer, sunshine recorder, schematic diagrams and principle of working. Solar Thermal Conversion: Collection and storage, thermal collection devices. Fundamentals of solar energy and photovoltaic (PV) technology, Types of solar power plants: grid- tied, off-grid, and hybrid systems, Design considerations for solar power	

plants: site selection, orientation, and shading analysis, PV system components and their functionalities, Operation, maintenance, and performance monitoring of solar power plants.

Textbook-1: Chapter 3 Textbook-2: Chapter 3

Module – 3	**08 Hrs**

Geothermal Energy: Forms of geothermal energy, Dry steam, wet steam, hot dry rock and magmatic chamber systems.

Tidal Energy: Tidal power, Site selection, Single basin and double basin systems, Advantages and disadvantages of tidal energy.

Wind Energy: Wind energy-Advantages and limitations, wind velocity and wind power, Basic components of wind energy conversion systems, horizontal and vertical axis wind mills, coefficient of performance of a wind mill rotor, Applications of wind energy.

Textbook-1: Chapter 4,5 Textbook-2: Chapter 3,4

Module – 4	**08 Hrs**

Hydroelectric plants: Advantages & disadvantages of water power, Hydrographs and flow duration curves- numericals, Storage and pondage, General layout of hydel power plants-components such as Penstock, surge tanks, spill way and draft tube and their applications, pumped storage plants, Detailed classification of hydroelectric plants, water hammer.

Ocean Thermal Energy: Ocean thermal energy conversion, Principle and working of Rankine cycle, Problems Associated with OTEC.

Textbook-1: Chapter 6,7 Textbook-3: Chapter 5,6

Module – 5	**08 Hrs**

Biomass Power Plants: Biomass as a renewable energy source: types and characteristics, Conversion technologies: combustion, gasification, and anaerobic digestion, biomass feedstock selection and availability, Environmental impacts and sustainability of biomass power plants, Integration of biomass power plants with other energy systems

Hydrogen Energy: Properties of Hydrogen with respected to its utilization as a renewable form of
energy, sources of hydrogen, production of hydrogen, electrolysis of water, thermal decomposition of water, thermos Chemical production bio-chemical production.

Textbook-1: Chapter 8,79Textbook-2: Chapter 5,6

Course Outcomes: After completing the course, the students will be able to	
CO1	Expound the environmental aspects of nonconventional energy resources in Comparison with various conventional energy systems, their prospects and limitations, the need of renewable energy resources, historical and latest developments.
CO2	Exploit the use of solar energy and the various components used in the energy production with respect to applications like heating, cooling, desalination, power generation, drying, cooking etc
CO3	Enumerate the need of Wind Energy and the various components used in energy generation and know the classifications.
CO4	Infer the concept of Biomass energy resources and their classification, types of biogas Plants applications.
CO5	Compare the working principles of fuel cells, wave power, tidal power and geothermal principles and applications.

Text Books	
1	Power Plant Engineering, P. K. Nag, Tata McGraw Hill Education Private Limited, New Delhi,
2	Power Plant Engineering, Arora and Domkundwar, Dhanpat Rai & Co. (P) Ltd.
3	Non-conventional Sources of Energy, G.D.Rai, Khanna Publishers, New Delhi

CO – PO MAPPING

COURSE OUTCOMES	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	1				2	3						
CO2	3	2	1	1			3						
CO3	3	2	1	1			3						
CO4	2	3					3						
CO4	3	1					3						

SJC INSTITUTE OF TECHNOLOGY, CHIKKABALLAPURA

An Autonomous institution Under VTU from 2024 – 2025

AICTE Approved, Accredited by NBA(CSE, ISE, ECE, ME, CV, AE) and NAAC with 'A+' grade, QS – I Gauge Gold Rated

SCHEME OF TEACHING AND EXAMINATION – B.E. – Mechanical Engineering

(Applicable for students admitted from the Academic Year 2024-25 and onwards)

8th Semester

Mechanical Engineering												
Sl. No.	**Course Code**	**Course Title**	**Course Type**	**TD/ PSB**	**Teaching Hours / Week**			**Examination**				
					L	**T**	**P**	**SEE Duration (Hrs)**	**CIE Marks**	**SEE Marks**	**Total Marks**	**Credits**
1	BME821x	Professional Elective Course - IV (Online Course) only through NPTEL / VTU MOOC / Centre Of Excellence of the concerned department	PEC	ME	3	0	0	**3**	**50**	**50**	**100**	**3**
2	BME842x	Open Elective Course - III (Online Course) only through NPTEL / VTU MOOC / Centre Of Excellence of the concerned department	OEC	ME	3	0	0	**3**	**50**	**50**	**100**	**3**
3	BME833	Internship (Industry / Research / Rural) (14 – 20 weeks)	INT	ME	0	0	12	**3**	**100**	**100**	**200**	**8**
									200	**200**	**400**	**14**

PEC: Professional Elective Course, OEC: Open Elective Course, INT: Industry Internship / Research Internship, L: Lecture, T: Tutorial, P: Practical, CIE: Continuous Internal Evaluation, SEE: Semester End Evaluation.

Professional Elective Course – IV (Online Course – only through NPTEL, suggested by BoS)

Course Code	Course Name	Course Code	Course Name
BME821A	Quality Design & Control (Available in NPTEL)	BME821C	Modelling & Analytics for Supply Chain Management (Available in NPTEL)
BME821B	Machinery Fault Diagnosis and Signal Processing (Available in NPTEL)	BME821D	Strategies for Sustainable Design (Available in NPTEL)

Open Elective Course – III (Online Course – only through NPTEL, suggested by BoS)

Course Code	Course Name	Course Code	Course Name

BME842A	Fundamentals of Automotive systems (Available in NPTEL)	BME842C	Computer Integrated Manufacturing (Available in NPTEL)
BME842B	Product Design and Manufacturing (Available in NPTEL)	BME842D	Business Planning & Project Management (Available in Swayam Portal)

Professional Elective Courses (PEC): A professional elective (PEC) course is intended to enhance the depth and breadth of educational experience in the Engineering and Technology curriculum. Multidisciplinary courses that are added supplement the latest trend and advanced technology in the selected stream of engineering. Each group will provide an option to select one course. The minimum number of students' strengths for offering professional electives is 10. However, this conditional shall not be applicable to cases where the admission to the program is less than 10.

Open Elective Courses: Students belonging to a particular stream of Engineering and Technology are not entitled to the open electives offered by their parent Department. However, they can opt for an elective offered by other Departments, provided they satisfy the prerequisite condition if any. Registration to open electives shall be documented under the guidance of the Program Coordinator/ Advisor/Mentor. The minimum numbers of students' strength for offering Open Elective Course is 10. However, this condition shall not be applicable to class where the admission to the program is less than 10.

Elucidation: At the beginning of IV years of the program i.e., after VI semester, VII semester classwork and VIII semester Research Internship /Industrial Internship / Rural Internship shall be permitted to be operated simultaneously by the University so that students have ample opportunity for an internship. In other words, a good percentage of the class shall attend VII semester classwork and a similar percentage of others shall attend to Research Internship or Industrial Internship or Rural Internship.

Research/Industrial /Rural Internship shall be carried out at an Industry, NGO, MSME, Innovation center, Incubation center, Start-up, center of Excellence (CoE), Study Centre established in the parent institute and /or at reputed research organizations/institutes.

The mandatory Research internship /Industry internship / Rural Internship is for 14 to 20 Weeks. The internship shall be considered as a head of passing and shall be considered for the award of a Degree. Those, who do not take up/complete the internship shall be declared to fail and shall have to complete it during the subsequent University examination after satisfying the internship requirements.

Research internship: A research internship is intended to offer the flavor of current research going on in the research field. It helps students get familiarized with the field and imparts the skill required for carrying out research.

Industry internship: Is an extended period of work experience undertaken by students to supplement their Degree for professional development. It also helps them learn to overcome unexpected obstacles and successfully navigate organizations, perspectives, and cultures. Dealing with contingencies helps students recognize, appreciate, and adapt to organizational realities by tempering their knowledge with practical constraints.

Rural Internship: Rural development internship is an initiative of Unnat Bharat Abhiyan Cell, RGIT in association with AICTE to involve students of all departments studying in different academic years for exploring various opportunities in techno-social fields, to connect and work with Rural India for their upliftment.

Credit Definition

1- hour Lecture (L) per week=1Credit 2- hoursTutorial(T) per week=1Credit	04-Credits courses are to be designed for 50 hours of Teaching-Learning Session 04-Credits (IC) are to be designed for 40 hours' theory and 12-14 hours of practical sessions
2-hours Practical / Drawing (P) per week=1Credit 2-hous Skill Development Actives (SDA) per week = 1 Credit	03-Credits courses are to be designed for 40 hours of Teaching-Learning Session 02- Credits courses are to be designed for 25 hours of Teaching-Learning Session 01-Credit courses are to be designed for 12-15 hours of Teaching-Learning sessions

Institute Vision

Preparing Competent Engineering and Management Professionals to Serve the Society

Institute Mission

- Providing Students with a Sound Knowledge in Fundamentals of their branch of Study.
- Promoting Excellence in Teaching, Training, Research and Consultancy.
- Exposing Students to Emerging Frontiers in various domains enabling Continuous Learning.
- Developing Entrepreneurial acumen to venture into Innovative areas.
- Imparting Value based Professional Education with a sense of Social Responsibility.

Department Vision

Building Technically Competent Engineers to Serve the Society

Department Mission

- Imparting strong fundamental knowledge in Mechanical Engineering and allied fields.
- Fostering a culture of collaboration and propagating Industry institute interactions to enhance advances in latest technologies.
- Creating State-of-Art facilities benefitting students and faculty to carryout Research, Innovation and Consultancy.
- Providing conducive environment for both students and faculty to engage in lifelong learning activities.
- Inculcating Professional ethics, Leadership qualities and Entrepreneurial skills among students.

SJC INSTITUTE OF TECHNOLOGY

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