YESHWANTRAO CHAVAN COLLEGE OF ENGINEERING
(An Autonomous Institution affiliated to R T M Nagpur University Nagpur)
Accredited by NAAC (1st Cycle) with 'A' Grade (Score 3.25 on 4 Point Scale)

Wanadongri, Hingna Road, Nagpur-441110

Department of Mechanical Engineering (Honors in TE)

B.E. Honors in Thermal Engineering (NPTEL Based) SoE & Syllabus 2021-22

B.E Honors in Thermal Engineering (NPTEL Based)

Information Brochure of Honor Program

1. Title of Program: **B.E. Honor in Thermal Engineering (NPTEL BASED)**
2. Type of Program : **Honor**
3. Department offering the program: **Mechanical Engineering**
4. Industry / Association / Collaboration: **NPTEL BASED.**
5. Department/s eligible to opt for the program: **Mechanical Department**

   The program can be opted only by the students Mechanical Engineering Department.

6. **General information about courses in program:**

   Thermal engineering is a specific stream of mechanical engineering that deals with the movement of thermal energy. Thermodynamics, Fluid Mechanics and Heat Transfer are the pillars of Thermal Engineering. The courses selected are a step ahead of what is studied, or covers the vital portion which is not studied, in regular course. The courses are aimed to impart knowledge in field of Heat exchange, fluid dynamics, thermodynamics, turbomachinery, renewable energy, refrigeration, air-conditioning, power plant, and aircraft propulsion. The course will lay a foundation of thermal engineering in field of power related industries and laboratories.

7. **Advance knowledge or research orientation of Program:**

   Thermal Engineering a basic course, related to the study and design of devices, technologies, systems involving thermal processes with an emphasis on engineering application. The scale of thermal engineering is quite broad and plays an important role in the development and application of advanced technology in almost every field. Thermal engineering is related to the design and development of components, equipment and systems involving thermal processes used for the production, storage, utilization and conservation of energy. The program will strengthen the fundamental and applied knowledge in thermal engineering which will assist students in ensuing the research.

8. **Employability potential of program:**

The study of basic and applied knowledge of thermal systems are important in industrial processes such as heat exchangers, turbines, boilers, pumps, compressors, HVAC etc. The program is designed to get the apt knowledge in the thermal engineering to prepare the students for a prolific career in the companies dealing with the design and fabrication of heat exchangers, automobile industries, process industries, oil refineries, waste heat recovery, renewable energy, HVAC industries, power plant industries, Pump and turbine industry and other power companies.

Some specific companies as mentioned in some of the various recommended NPTEL courses could be: BHEL, ALSTOM, HP, HPCL, IOCL, THERMAX, BPCL, GAIL, Reliance, TATA Chemicals NTPC, CPRI, BARC, NPCL, BHEL, CESC, WBSEB, DVC, Siemens, Alstom, HAL, GTRE, NHPC, GE India etc.

9. Departmental Steering committee: For proper publicity / conduct of program:

SN	Name of the Faculty Member	Post	Designation	e-mail ID	Contact Number
1	Dr. S. S. Chaudhari	Chairman	HOD	hod_me@ycce.edu	9545531727
2	Dr.J.P.Giri	Member	Associate Professor	jayantpgiri@gmail.com	9822929871
3	Prof.A.P.Edlabadkar	Member	Assistant Professor	ajinkyae@gmail.com	9764478622
4	Prof.A.R.Narkhede	Member	Assistant Professor	alok.narkhede@gmail.com	7666767483

10. Departmental coordinator

SN	Name of the Faculty Member	Post	Designation	e-mail ID	Contact Number
1	Prof.A.R.Narkhede	Member	Assistant Professor	alok.narkhede@gmail.com	7666767483

Scheme of Examinations
B.E Honors in Thermal Engineering (NPTEL Based)

SN	Sem	Sub.Code	Subject	T/P	Contact Hours				Credits	% Weightage			ESE Duration Hours
					L	T	P	Hrs		MSEs*	TA**	ESE	
1	5	MEHN01	Fluid Machines	T	3	0	0	3	3	This is SWAYAM / NPTEL based program and subjects with 12–14-week syllabus are expected to be available on SWAYAM/NPTEL platform. If they are not available before the commencement of semester, Similar / Equivalent Subjects shall be notified by BoS of the Department. Chairman BoS will notify all the subjects which are 12-14 week duration before the commencement of academic session			
2	5	MEHN02	Fluid dynamics and turbomachines	T	3	0	0	3	3				
3	5	MEHN03	Applied Thermodynamics For Engineers	T	3	0	0	3	3				
4	6	MEHN11	Introduction to Turbomachinery	T	3	0	0	3	3				
5	6	MEHN12	Heat Exchangers: Fundamentals and Design Analysis	T	3	0	0	3	3				
6	7	MEHN21	Fundamentals of Conduction and Radiation	T	3	0	0	3	3				
			TOTAL		**17**	**0**	**2**	**18**	18				

MSEs* = Three MSEs of 15 Marks each will conducted and marks of better 2 of these 3 MSEs will be considered for Continuous Assessment

TA ** = for Theory : 20 marks on lecture quizzes, 8 marks on assignments, 2 marks on class performance
TA = for Practical : MSPA will be 15 marks each**

Syllabus

Fluid Mechanics

COURSE OUTLINE

Properties of fluids and fundamental concepts, Fluid statics and its applications, Kinematics of fluids, Conservation equations in fluid flow and its applications, Incompressible viscous flow with applications to pipe flow in practice, Principles of similarity, Flow of ideal fluids Flow with free surface, Few unsteady flow phenomena in practice, Introduction to laminar boundary layer, Introduction to turbulent flow,

The course coverage is balanced with analytical treatments, physical concepts and practical applications.

COURSE DETAIL

Modules	Lecture Topics
Module: 1	Lecture 1: Introduction and Fundamental Concepts Part-I Lecture 2: Introduction and Fundamental Concepts Part-II Lecture 3: Introduction and Fundamental Concepts Part-III
Module: 2	Lecture 4: Fluid Statics Part-I Lecture 5: Fluid Statics Part-II Lecture 6: Fluid Statics Part-III Lecture 7: Fluid Statics Part-IV Lecture 8: Fluid Statics Part-V Lecture 9: Fluid Statics Part-VI
Module: 3	Lecture 10: Kinematics of Fluid Part-I Lecture 11: Kinematics of Fluid Part-II Lecture 12: Kinematics of Fluid Part-III
Module: 4	Lecture 13: Conservation Equations in Fluid Flow Part-I Lecture 14: Conservation Equations in Fluid Flow Part-II
Module: 5	Lecture 15: Conservation Equations in Fluid Flow Part-III Lecture 16: Conservation Equations in Fluid Flow Part-IV Lecture 17: Conservation Equations in Fluid Flow Part-V Lecture 18: Conservation Equations in Fluid Flow Part-VI Lecture 19: Conservation Equations in Fluid Flow Part-VII Lecture 20: Conservation Equations in Fluid Flow Part-VIII Lecture 21: Conservation Equations in Fluid Flow Part-IX

Module: 6	Lecture 22: Fluid Flow Applications Part-I Lecture 23: Fluid Flow Applications Part-II Lecture 24: Fluid Flow Applications Part-III Lecture 25: Fluid Flow Applications Part-IV Lecture 26: Fluid Flow Applications Part-V Lecture 27: Fluid Flow Applications Part-VI Lecture 28: Fluid Flow Applications Part-VII
Module: 7	Lecture 29: Incompressible Viscous Flows Part-I Lecture 30: Incompressible Viscous Flows Part-II Lecture 31: Incompressible Viscous Flows Part-III Lecture 32: Incompressible Viscous Flows Part-IV
Module: 8	Lecture 33: Application of Viscous Flow through Pipes Part-I Lecture 34: Application of Viscous Flow through Pipes Part-II Lecture 35: Application of Viscous Flow through Pipes Part-III
Module: 9	Lecture 36: Principles of Similarity Part-I Lecture 37: Principles of Similarity Part-I Lecture 38: Principles of Similarity Part-I
Module: 10	Lecture 39: Flow of Ideal Fluids Part-I Lecture 40: Flow of Ideal Fluids Part-II
Module: 11	Lecture 41: Flows with a Free Surface Part-I Lecture 42: Flows with a Free Surface Part-II Lecture 43: Flows with a Free Surface Part-III
Module: 12	Lecture 44: A Few unsteady Flow Phenomena Part-I Lecture 45: A Few unsteady Flow Phenomena Part-II
Module: 13	Lecture 46: Introduction to Laminar Boundary Layer Part-I Lecture 47: Introduction to Laminar Boundary Layer Part-II
Module: 14	Lecture 48: Introduction to Turbulent Flow Part-I Lecture 49: Introduction to Turbulent Flow Part-II

References:

1. S K Som, G Biswas, Suman Chakraborty, Introduction to Fluid Mechanics and Fluid machines, Tata McGraw Hill Eduction.
2. R. W. Fox, P. J. Pritchard, A. T Mcdonald, Introduction to Fluid Mechanics, John Wiley
3. F. M White, Fluid Mechanics, Tata McGraw Hill Eduction.

FLUID DYNAMICS AND TURBOMACHINES

PRE-REQUISITES : 1. Basic Engineering Mathematics 2. Engineering Mechanics 3. Basic Engineering Thermodynamics

INTENDED AUDIENCE : 1. Undergraduate students 2. Practicing engineers (refresher course)

INDUSTRIES APPLICABLE TO : Pump and turbine industry

COURSE OUTLINE :

The first part of the course introduces important concepts of fluid dynamics which forms the theoretical foundation for the second portion of the course on turbomachines. The course is intended for advanced

B. Tech/B. E. students as well as a refresher course for practicing engineers working in the field of pump and turbine industries.

ABOUT INSTRUCTOR :

Prof. Dhiman Chatterjee is currently an Associate Professor in the department of Mechanical Engineering, IIT Madras. He teaches Incompressible Fluid Flow and Turbomachines. His research specialization includes turbomachines and cavitation.

Prof. Shamit Bakshi is currently an Associate Professor in the department of Mechanical Engineering, IIT Madras. He teaches Incompressible Fluid Flow and IC Engines. His research specialization includes droplet/spray processes and I.C. Engine flows.

COURSE PLAN :

Week 1**:** Introduction to fluid flows

Week 2**:** Integral approach for analyzing fluid flow

Week 3**:** Differential approach for analyzing fluid

flow **Week** 4**:** Incompressible viscous internal and

external flow **Week** 5**:** Introduction to

turbomachines

Week 6**:** Principle of turbomachines

Week 7**:** Performance of pump and hydraulic turbine

Week 8**:** Performance of steam and gas turbine

APPLIED THERMODYNAMICS FOR ENGINEERS

PRE-REQUISITES : Fundamentals of Thermodynamics

INTENDED AUDIENCE : Undergraduate students of Mechanical Engg and similar branches; Faculty members associated with Mechanical Engineering; Practicing engineers associated with Thermal Industries (such as Power, Automobile, Airconditioning etc.).

COURSE OUTLINE:
Thermodynamics is a subject of fundamental interest to Mechanical engineers and therefore is always taught in the 2nd or 3rd semester. Present course can be viewed as the next step, where the thermodynamic principles will be employed to discuss about different power producing & absorbing cycles. Properties of pure substance will be discussed, along with the thermodynamic property relations, thereby enabling the participants to estimate all relevant thermodynamic properties at any particular state of point. Subsequently the gas & vapor power cycles will be analyzed, followed by the principles of cogeneration & combined cycles. Then the refrigeration cycles will be introduced, followed by a discussion on the selection of refrigerants. The properties of gas mixtures and gas-vapor mixtures will also be discussed, leading to psychrometry & psychrometric processes. The course will be completed with a brief introduction to the chemical equilibrium.

ABOUT INSTRUCTOR :

Dr. Dipankar N. Basu is an Associate Professor in the department of Mechanical Engineering at Indian Institute of Technology Guwahati since June 2012. He received his undergraduate and postgraduate degree from Jadavpur University, Kolkata, and completed his Ph.D. from Indian Institute of Technology Kharagpur in 2011. He served as an Assistant Professor at IIEST Shibpur for nearly four years before joining IIT Guwahati. His principal research interest is in the field of nuclear thermalhydraulics, two-phase flow, supercritical heat transfer, optimization of thermal systems and microchannel heat transfer. He is currently working on computational tool development for simulation of flows with free-surfaces. He has co-authored more than 65 referred journal and conference publications and also a book chapter on supercritical natural circulation loop. He is a regular reviewer of many reputed international journals and also associated with several sponsored projects.

COURSE PLAN :

Week 1: Review of Thermodynamic Principles

Week 2: Thermodynamic Property Relations

Week 3: Properties of Pure Substances

Week 4: Air Standard Cycles

Week 5: Real Cycles for Reciprocating Engines

Week 6**:** Gas Turbine Cycles

Week 7**:** Vapor Power Cycles

Week 8**:** Cogeneration & Combined Cycles

Week 9**:**Refrigeration Cycles

Week 10**:** Gas Mixtures

Week 11**:** Gas-vapor Mixtures

Week 12**:** Chemical Reactions

INTRODUCTION TO TURBOMACHINERY

PRE-REQUISITES : Basic Thermodynamics and Fluid Mechanics

INTENDED AUDIENCE : UG/PG students, research scholars, and practicing engineers interested in the field of turbomachinery.

INDUSTRIES APPLICABLE TO : HAL/GTRE/NTPC/NHPC/BHEL/GE India etc

COURSE OUTLINE :

The objective of the course is to provide a framework to discuss different kinds of turbomachinery through a unified approach. The material presented is intended for undergraduate and graduate students apart from professional engineers in the industry engaged in the analysis and development of turbomachinery. Coverage begins with the fundamental concepts, the equations of motion in a rotating system, and the Euler equation for turbomachinery. This is followed by the gas turbine cycle, similarity rules, and cascade flow analysis. The reader is then focused on flows through compressors and turbines, including a brief discussion on the secondary flow, tip clearance, blade cooling, surge, and stall. The course will be concluded with a discussion on CFD in the design and analysis of turbomachinery.

ABOUT INSTRUCTOR :

S. Sarkar, Professor of the Department of Mechanical Engineering at the Indian Institute of Technology Kanpur, India, HAL Chair, Convener of Energy Conversion and Computational Turbomachinery Laboratories, received Ph.D. in 1995. He also severed the University of Surrey, UK for two years. Dr. Sarkar is involved in research over the last 25 years and contributed significantly to the fields of Fluid Mechanics, Turbulence, Turbomachinery, CFD, and Large-Eddy Simulation. He is the author of several peer-reviewed technical papers in international journals and conferences, and has guided a number of masters and doctoral students. He has completed many industrial and sponsored projects. He has served as a technical expert on project-review committees of national importance, and also served on numerous academic and administrative committees of the Institute.

COURSE PLAN :

1. Introduction and Classification: Axial flow, radial flow and mixed flow machines, the equations of motion in rotating frame of reference, effects of Coriolis and Centrifugal forces, momentum and energy equation, Euler work, and illustrative examples.[5]

2. Gas Turbine Cycle: Brayton Cycle, regenerative cycle, reheat, inter-cooling, turboprop, turbojet and turbofan engine, thrust augmentation, and illustrative examples. [4]

3. Similarity Analysis: Similarity rules, specific speed, Cordier diagram and illustrative examples.[4]

4. Cascade Analysis: Two-dimensional cascade theory, lift and drag, blade efficiency, estimation of loss, compressor and turbine cascade, blade geometry, and illustrative examples.[5]

5. Axial Flow Compressor: Two-dimensional pitch line design and analysis, h-s diagram, degree of reaction, the effect of Mach number, performance and efficiency, three-dimensional flow, tip clearance, losses, compressor performance, and illustrative examples. [6]

6. Centrifugal Pump and Compressor: Theoretical analysis and design, the effect of circulation and Coriolis forces, reversal eddies, slip factor, head and efficiency, diffuser, introduction to the combustion system, and illustrative examples.[6]

7. Axial Flow Turbine: Two-dimensional pitch line design, stage loading capacity, degree of reaction, stage efficiency, turbine performance, blade cooling, and illustrative examples.[6]

8. CFD Applied to Turbomachinery Flows: Governing equations, numerical methods, and test cases illustrating flow and heat transfer related to turbomachines.

Total Class: 36 (It equivalent to 12 weeks considering 3 classes per week)

HEAT EXCHANGERS: FUNDAMENTALS AND DESIGN ANALYSIS

PREREQUISITES : Thermodynamics, Fluid Mechanics and Heat Transfer (at a very basic level).

INDUSTRY SUPPORT : All the companies generating coal based and nuclear based power (NTPC, different state electricity boards, CPRI, BARC, andNPCL etc.). Companies dealing with the design and fabrication of heat exchangers, auto mobile industries, process industries, oil refineries. Companies dealing with waste heat recovery and renewable. Some specific companies could be BHEL, ALSTOM, HP, HPCL, IOCL, THERMAX, BPCL, GAIL, Reliance, TATA Chemicals etc

COURSE OUTLINE :

Heat exchangers are extensively used in diverse industries covering power generation, refrigeration and air conditioning, cryogenics, oil refineries and chemical processes, automobiles and other transport devices. The performance of a heat exchanger is very important for the conservation of energy, assurance of product quality, process viability and environmental protection. The present course aims at developing a familiarity with various types of heat exchangers, their construction and applications. Conventional methods of heat exchanger analysis; brief design methodology of typical heat exchangers and synthesis of heat exchanger network. It is planned to develop an appreciation and basic expertise in heat exchanger through description, mathematical analysis and numerical examples

ABOUT INSTRUCTOR :

Prof. Prasanta Kumar Das is a Professor of Mechanical Engineering and presently the Dean Post Graduate Studies and Research at IIT Kharagpur. He possesses a vast experience in teaching and research. His research interests lie in the broad area of thermal engineering with a special emphasis on two phase flow.

Prof.Indranil Ghosh received his B. Sc. and M. Sc. in Physics from Jadavpur University in 1990 and 1992 respectively, M.Tech and Ph.D. from the Cryogenic Engineering Centre, Indian Institute of Technology, Kharagpur in 1995 and 2005 respectively

COURSE PLAN :

Week 01 : Background, Application, Classification, Common terminologies

Week 02 : Introduction to Thermal and hydraulic aspects, pressure drop and heat transfer, sizing and rating. F-LMTD and -NTU method

Week 03 : Tubular Heat Exchangers: different designs, brief description of Shell and Tube Heat Exchangers, Special types.

Week 04 : Compact heat exchangers, enhancement of heat transfer, extended surface or Fin, fundamental of extended surface heat transfer, Fin tube heat exchanger

Week 05 : Plate Fin Heat Exchangers (PFHE), types, construction, fabrication, design, application. Multistream PFHE

Week 06 : Multistream PFHE continued. Direct contact heat exchangers, types, application, simple analysis.

Week 07 : Regenerators, types of regenerators, construction, application. Theory of Regenerator, NTU and method

Week 08 : Heat pipes, construction, working principle, application, analysis. Special heat pipes.

Week 09 : Microscale Heat Exchangers and heat sinks; heat transfer and fluid flow through narrow conduits, special design considerations

Week 10 : phase change heat transfer, introduction to evaporators and condensers. Phase change HEX;

Week 11 : phase change heat transfer, introduction to evaporators and condensers.

Week 12 : Heat Exchanger testing, steady state and dynamic methods

FUNDAMENTALS OF CONDUCTION AND RADIATION

PREREQUISITES: Heat transfer is a topic of fundamental interest in mechanical engineering and hence any engineering firm &concerned industry should find this course interesting & valuable.

COURSE OUTLINE :

This is introductory course on conduction and radiation heat transfer. This course emphasizes the fundamental concepts and provides detailed solution methodology. This course will provide students with the tools to model, analyze and solve a wide range of engineering applications involving conduction and radiation heat transfer.

ABOUT INSTRUCTOR :

Prof. Amaresh Dalal is currently an Associate Professor in the Department of Mechanical Engineering of the Indian Institute of Technology, Guwahati. He received his PhD degree from Indian Institute of Technology Kanpur in 2009 and he was Post-doctoral Research Associate at Purdue University from Sep 2008 - Dec 2009. He has research interests in the area of Computational Fluid Dynamics and Heat Transfer, Finite Volume Methods and Unstructured Grid Techniques, Multiphase Flows. Dr. Dalal is now profoundly involved in developing a general purpose, versatile and robust computational fluid dynamics solver over hybrid unstructured grid which can solve a wide range of real-life fluid flow, heat transfer, and problems involving transport phenomena over complex geometries.

Dr. Dipankar N. Basu is an Associate Professor in the department of Mechanical Engineering at Indian Institute of Technology Guwahati since June 2012. He received his undergraduate and postgraduate degree from Jadavpur University, Kolkata, and completed his Ph.D. from Indian Institute of Technology Kharagpur in 2011. He served as an Assistant Professor at IIEST Shibpur for nearly four years before joining IIT Guwahati. His principal research interest is in the field of nuclear thermal hydraulics, two-phase flow, supercritical heat transfer, optimization of thermal systems and microchannel heat transfer. He is currently working on computational tool development for simulation of flows with free-surfaces. He has co- authored more than 65 referred journal and conference publications and also a book chapter on supercritical natural circulation loop. He is a regular reviewer of many reputed international journals and also associated with several sponsored projects.

COURSE PLAN :

Week 1: Introduction to Heat Transfer

Week 2: Introduction to Conduction

Week 3: 1-D Steady-state Heat Conduction

Week 4: Special 1-D Heat Conduction Situations

Week 5: Heat Transfer from Extended Surfaces

Week 6: 2-D Steady-state Heat Conduction

Week 7: Transient Heat Conduction

Week 8: Numerical Methods in Conduction

Week 9: Fundamentals of Radiation Heat Transfer

Week 10: Radiative Properties of Real Surfaces

Week 11: Radiation Exchange between Surfaces

Week 12 : Radiation Exchange with Participating Media