Walchand College of Engineering

(Government Aided Autonomous Institute)

Vishrambag, Sangli-416415

Course Content for F. Y. M. Tech. (Thermal Engineering)

Semester-I

2024-25

Walchand College of Engineering, Sangli

(Government Aided Autonomous Institute)

AY 2024-25

Course Information

Programme	M. Tech. All Branches
Class, Semester	First Year M. Tech., Sem I
Course Code	7IC501
Course Name	Research Methodology
Desired Requisites:	

Teaching Scheme		**Examination Scheme (Marks)**			
Lecture	3 Hrs/week	**MSE**	**ISE**	**ESE**	**Total**
Tutorial	---	30	20	50	100
		Credits: 3			

Course Objectives

1	To prepare students for undergoing research, identify and formulate the research problems, state the hypothesis, design a research layout, set a research process and methodology.
2	To enable students to interpret the results, propose theories, suggest possible/alternative solutions, solve, and prove the solution adapted–logically and analytically, conclude the research findings.
3	To impart knowledge to analyze critically the literature and publish research in reputed conferences/ journals.
4	To expose students to research ethics, IPR and Patents

Course Outcomes (CO) with Bloom's Taxonomy Level

At the end of the course, the students will be able to,

CO	**Course Outcome Statement/s**	**Bloom's Taxonomy Level**	**Bloom's Taxonomy Description**
CO1	Demonstrate a research solution in each engineering domain using appropriate Engineering research process and research methodology.	II	Apply
CO2	Device feasible solution to a research problem in the respective engineering domain based on economic, social and legal aspects using appropriate research procedures and practices.	III	Analyze
CO3	Compose research publications and dissertation reports efficiently.	VI	Create
CO4	Draft IPR and patent documents, as well as copyright documentation for research work.	VI	Create

Module	**Module Contents**	**Hours**
I	**Engineering Research Process:** Meaning of research problem, Sources of research problem, Criteria and Characteristics of a good research problem, Errors in selecting a research problem, Definition, scope and objectives of research problem. Approaches of investigation of solutions for research problem, data collection, analysis, interpretation.	6
II	**Research Methodology :** Problem statement formulation, resources identification for solution, Experimental and Analytical modeling, Simulations, Numerical and Statistical methods in engineering research. Hypothesis and its testing by different techniques: T-Test, Z-test etc.	6
III	**Research Methods:** Uni and Multivariate Analysis: ANOVA, Design of Experiments/Taguchi Method, Regression Analysis. Software tools like spreadsheets.	7

	Processing and Analysis of Data: Processing Operations, Types of Analysis-Presentation and Interpretation of Data Editing, Classification and Tabulation-Interpretation. Analyse your results and draw conclusions.	
IV	**Research Practices:** Effective literature studies approaches, critical analysis, Plagiarism, Research ethics, Mendeley - Reference Management Software. Research communication- Effective Technical Writing, Writing a research article for Journal/conference paper, Technical report, Dissertation/ Thesis report writing, Software used for report writing such as word, Latex etc. Presentation techniques for paper/report/seminar. Publishing article in Scopus/SCI/Web of science indexed journal or conference.	7
V	**Intellectual Property Rights (IPR):** Nature of Intellectual Property: Patents, Designs, Trade and Copyright, Ownership of copyright, Term of copyright, Technological research, innovation, patenting, development. International Scenario: International cooperation on Intellectual Property, New developments in IPR, Traditional knowledge, Various Case Studies.	7
VI	**Patents** Patent Rights: Scope of Patent Rights, Various Patent databases, Geographical Indications. Procedure for grants of patents, Patenting under Patent Cooperation Treaty (PCT). Licensing and transfer of technology. Administration of Patent System. Introduction to International Scenario: World Intellectual Property Organization (WIPO), Trade-Related Aspects of Intellectual Property Rights (TRIPs), Patenting under PCT.	6

	Textbooks
1	Kothari C. R, "Research Methodology", 5th Edition, New Age International, 2023
2	Melville Stuart and Goddard Wayne, "Research Methodology: An Introduction for Science & Engineering Students" Juta and Company Ltd, 4th edition 2023.
3	Kumar Ranjit, "Research Methodology: A Step-by-Step Guide for beginners", SAGE Publications, , 4th edition 2023.
	References
1	Merges Robert, Menell Peter, Lemley Mark, "Intellectual Property in New Technological Age", ASPEN Publishers, 2018.
2	Ramappa T., "Intellectual Property Rights Under WTO", S. Chand, 2008
3	Mayall, "Industrial Design", McGraw Hill, Oct 2021.
4	Halbert, "Resisting Intellectual Property", Taylor & Francis Ltd ,2020
5	Deepak Chopra and Neena Sondhi, "Research Methodology : Concepts and cases ", Vikas Publishing House, New Delhi
	Useful Links
1	https://onlinecourses.nptel.ac.in/noc21_ge03/preview- Introduction to reseach
2	https://onlinecourses.swayam2.ac.in/ntr21_ed23/preview - Academic Research & Report Writing
	https://onlinecourses.nptel.ac.in/noc21_ge12/preview - Qualitative Research Methods And Research Writing
5	https://onlinecourses.nptel.ac.in/noc21_hs44/preview - Effective Writing
6	https://www.scopus.com/search/form.uri?display=basic#basic
7	https://webofscienceacademy.clarivate.com/learn
9	https://www.wipo.int/about-wipo/en/
10	https://iprsearch.ipindia.gov.in/publicsearch

CO-PO Mapping						
	Programme Outcomes (PO)					
	1	**2**	3	4	5	6
CO1	2	2	1			
CO2	3	2	2	3	2	2
CO3		3		3	1	
CO4				3	1	
The strength of mapping is to be written as 1: Low, 2: Medium, 3: High Each CO of the course must map to at least one PO.						

Assessment

The assessment is based on MSE, ISE and ESE. MSE shall be typically on modules 1 to 3.
ISE shall be taken throughout the semester in the form of teacher's assessment. Mode of assessment can be field visit, assignments etc. and is expected to map at least one higher order PO.
ESE shall be on all modules with around 40% weightage on modules 1 to 3 and 60% weightage on modules 4 to 6.
For passing a theory course, Min. 40% marks in (MSE+ISE+ESE) are needed and Min. 40% marks in ESE are needed. (ESE shall be a separate head of passing)

Walchand College of Engineering, Sangli

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AY 2024-25

Course Information	
Programme	M. Tech. (Thermal Engineering)
Class, Semester	First Year M. Tech., Sem I
Course Code	1TH501
Course Name	Thermodynamics and combustion
Desired Requisites:	Requisite Courses: Basic Mathematics, Chemistry

Teaching Scheme		**Examination Scheme (Marks)**			
Lecture	3 Hrs/week	**MSE**	**ISE**	**ESE**	**Total**
Tutorial	-	30	20	50	100
		Credits: 3			

Course Objectives	
1	Students will get Knowledge of exergy, basic laws governing energy conversion in multicomponent systems and application of chemical thermodynamics.
2	Student will be aware about advanced concepts in thermodynamics with emphasis on the thermodynamic relations, equilibrium and stability of multiphase multi-component systems
3	Student will be acquire the confidence in analyse the motion of combusting and no combusting fluids whilst accounting for variable specific heats, non-ideal gas properties, chemical no equilibrium and compressibility

Course Outcomes (CO)

At the end of the course, the students will be able to,

CO	**Course Outcome Statement/s**	**Bloom's Taxonomy Level**	**Bloom's Taxonomy Description**
CO1	Explain the concepts of thermodynamics and kinetics of combustion	II	Understanding
CO2	Apply the concepts of Thermodynamics and combustion phenomena in energyconversion devices.	III	Applying
CO3	Analyse the combustion mechanisms of various fuels.	IV	Analysing
CO4	Evaluate entropy change for flow and non-flow processes under steady and unsteady conditions	V	Evaluating

Module	**Module Contents**	**Hours**
I	**Laws of Thermodynamics** Zeroth and First Law of Thermodynamics applied to macroscopic systems. Second Law analysis applied to macroscopic systems. Concept & Evaluation of entropy, Clausius inequality, Principle of increase of entropy.	7
II	**Second Law Analysis of Thermodynamic Systems** Introduction, Thermodynamic availability, Second Law Analysis of Closed Systems and Open Systems.	7
III	**Generalized Thermodynamic Relationship** Thermodynamic Relations Mathematical theorems, Helmoltz and Gibb's function, T-ds equations, Maxwell's relations, energy equations, variation in heat capacities, Clapeyron relation	7
IV	Combustion and Thermo-chemistry, Second law analysis of reacting mixture, Availability analysis of reacting mixture, Chemical equilibrium	7
V	Statistical thermodynamics, statistical interpretations of first and second lawand Entropy.	6
VI	**Combustion Thermodynamics** Combustion Thermodynamics, Heat of Reaction, Calorific Value, Adiabatic Flame Temp, Combustion Kinetics. Gas, Liquid and Solid Combustion.	6

Text Books	
1	An Introduction to Thermodynamics, Y.V.C. Rao, University Press (India) Private Limited, Revised Edition, 2004).
2	Thermodynamics: an Engineering Approach, Y.A.Cengal and M.A.Boles, McGraw Hill (Fifthedition).
3	Fundamentals of Classical Thermodynamics, G.VanWylen, R.Sonntag and C.Borgnakke , John Willey & Sons (Fourth edition).

References	
1	Cengel, “Thermodynamics”, Tata McGraw Hill Co., New Delhi, 1980.
2	Howell and Dedcius, “Fundamentals of Engineering Thermodynamics”, McGraw Hill Inc., U.S.A
3	Van Wylen& Sonntag, “Thermodynamics”, John Wiley and Sons Inc., U.S.A
4	Jones and Hawkings, “Engineering Thermodynamics”, John Wiley and Sons Inc., U.S.A, 2004.
5	Holman, “Thermodynamics”, McGraw Hill Inc., New York, 2002.
6	Faires V.M. and Simmang, “Thermodynamics”, Macmillan Publishing Co. Inc., U.S.A.
7	Rao Y.V.C., “Postulational and Statistical Thermodynamics”, Allied Publishers Inc, 1994

Useful Links	
1	https://youtu.be/lvy8h-yWhRQ
2	https://youtu.be/JIDK5iyatBk
3	https://youtu.be/EYKeBg4DmHI

CO-PO Mapping

	Programme Outcomes (PO)					
	1	**2**	**3**	**4**	**5**	**6**
CO1		1	2			
CO2		1			3	
CO3			2	3		
CO4					3	2

The strength of mapping is to be written as 1,2,3; Where, 1:Low, 2:Medium, 3:High
Each CO of the course must map to at least one PO.

Assessment

The assessment is based on MSE, ISE and ESE.
MSE shall be typically on modules 1 to 3.
ISE shall be taken throughout the semester in the form of teacher’s assessment. Mode of assessment can be field visit, assignments etc. and is expected to map at least one higher order PO.
ESE shall be on all modules with around 40% weightage on modules 1 to 3 and 60% weightage on modules 4 to 6.
For passing a theory course, Min. 40% marks in (MSE+ISE+ESE) are needed and Min. 40% marks in ESE are needed. (ESE shall be a separate head of passing)

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Course Information

Programme	M. Tech. (Thermal Engineering)
Class, Semester	First Year M. Tech., Sem I
Course Code	1TH502
Course Name	Advanced Fluid Dynamics
Desired Requisites:	Fluid Mechanics

Teaching Scheme		**Examination Scheme (Marks)**			
Lecture	3 Hrs/week	**MSE**	**ISE**	**ESE**	**Total**
Tutorial	-	30	20	50	100
		Credits: 3			

Course Objectives

1	To enable the students to analyze and solve fluid related problems by applying principlesof mathematics, science and engineering.
2	To prepare students to use modern tools, techniques and skills to fulfil industrial needs related to fluid dynamics.
3	To train students with effective communication skill to demonstrate fluid dynamicstheories.
4	To develop skills in the analysis of fluid systems with mathematical modeling for applications of fluid dynamics in research or design.
5	To develop a professional approach for lifelong learning in the fluid dynamics to include the awareness of social and environment issues associated with engineering practices.

Course Outcomes (CO) with Bloom's Taxonomy Level

At the end of the course, the students will be able to,

CO	Course Outcome Statement/s	Bloom's Taxonomy Level	Bloom's Taxonomy Description
CO1	Describe and define the fluid flow problems along with range ofgoverning parameters	II	Understanding
CO2	Devise the experiments in the field of fluid mechanics.	III	Applying
CO3	Analyze the flow patterns and differentiate between the flow regimes andits effects.	IV	Analyzing
CO4	Evaluate the performance of turbomachinery.	V	Evaluating

Module	Module Contents	Hours
I	**Basic equations of flow** Kinematics of flow, Control volume approach, Continuity equation, Momentum equation Linear momentum equation and angular momentum equation, Energy equation, Bernoulli equation	7

II	**Theory of Potential Flow and Hydrodynamic Stability** Kelvin's theorem, Stream function and Velocity potential, Irrational flow, Laplace equation and various flow fields, Combined flows and super positions, Examples of transition, Theoretical determination of Critical Reynolds Number,	7
III	**Flow over immersed bodies and boundary layer flow** Boundary layer equations, flow over flat plate, Boundary layers with non-zero pressure gradient, Approximate methods for boundary layer equations, separation and vortex shedding.	7
IV	**Turbulent flow** Characteristics of Turbulent flow, Laminar turbulent transition, Governing equations for turbulent flow, Turbulent boundary layer equations, measurement of turbulent quantities, shear stress models, universal velocity distribution and friction factor, fully developed turbulent flow, Dynamics of turbulence	7
V	**Turbo machinery** Equations of turbomachinery, Axial flow turbines, compressors, pumps and fans, Radial flow turbines, compressors, pumps and fans, Power absorbing vs. power producing devices, Performance characteristics of centrifugal pumps, Performance characteristics of hydraulic turbines	6
VI	**Compressible Fluid Flow** One dimensional compressible fluid flow – flow through variable area passage – nozzles and diffusers, effect of viscous friction and heat transfer, fundamentals of supersonics flow normal and oblique shock waves and calculation of flow and fluid properties over solid bodies (like flat plate, wedge, diamond) using gas tables	6

	Text Books
1	Muralidhar and Biswas, Advanced Engineering Fluid Mechanics, , Alpha Science International, 2005
2	Irwin Shames, Mechanics of Fluids, , McGraw Hill, 2003
	References
1	Fox R.W., McDonald A.T , *Introduction to Fluid Mechanics*, John Wiley and Sons Inc, 1985
2	Pijush K. Kundu, Ira M Kohen and David R. Dawaling, *Fluid Mechanics*, FifthEdition, 2005
	Useful Links
1	https://youtu.be/H38vI93exns
2	https://youtu.be/DevReEKIYw8
3	https://youtu.be/IaqRi9qcNJI
4	https://youtu.be/lneVkFukEKk

CO-PO Mapping						
	Programme Outcomes (PO)					
	1	**2**	**3**	**4**	**5**	**6**
CO1	2		2	2	2	
CO2		2				2
CO3				1	2	1
CO4					3	2
The strength of mapping is to be written as 1,2,3; Where, 1:Low, 2:Medium, 3:High Each CO of the course must map to at least one PO.						

Assessment
The assessment is based on MSE, ISE and ESE. MSE shall be typically on modules 1 to 3. ISE shall be taken throughout the semester in the form of teacher's assessment. Mode of assessment can be field visit, assignments etc. and is expected to map at least one higher order PO. ESE shall be on all modules with around 40% weightage on modules 1 to 3 and 60% weightage on modules 4 to 6. For passing a theory course, Min. 40% marks in (MSE+ISE+ESE) are needed and Min. 40% marks in ESE are needed. (ESE shall be a separate head of passing)

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AY 2024-25

Course Information	
Programme	M. Tech. (Thermal Engineering)
Class, Semester	First Year M. Tech., Sem I
Course Code	1TH503
Course Name	Advanced Heat Transfer
Desired Requisites:	Basic heat transfer

Teaching Scheme		**Examination Scheme (Marks)**			
Lecture	3 Hrs/week	**MSE**	**ISE**	**ESE**	**Total**
Tutorial	-	30	20	50	100
		Credits: 3			

Course Objectives	
1	To provide the student with general techniques to formulate, model and mathematicallysolve advanced heat transfer problems;
2	To provide the student with a detailed, but not exhaustive, presentation of selectedadvanced topics in convective heat transfer that are representative of “real world” engineering problems;
3	To introduce basic numerical methods and software tools for solving heat transferproblems.
4	To use appropriate analytical and computational tools to investigate heat and masstransport Phenomena.

Course Outcomes (CO) with Bloom’s Taxonomy Level

At the end of the course, the students will be able to,

CO	**Course Outcome Statement/s**	**Bloom’s Taxonomy Level**	**Bloom’s Taxonomy Description**
CO1	Explain the physical modelling aspects of heat transfer and an ability to make the appropriate choice between exact and approximate calculations in solving problems of heat transfer in complex systems.	II	Understanding
CO2	Identify the analogy of flow and momentum diffusion to heat and mass transfer and identify the interdisciplinary character of real-life thermal engineering.	III	Applying
CO3	Analyse heat transfer in complex internal flow systems and in boundarylayers and external flow configurations	IV	Analyzing
CO4	Evaluate radiation heat transfer between black body and gray body surfaces & Gas radiation	V	Evaluating

Module	**Module Contents**	**Hours**
I	Conduction- One and Two Dimensions.	7
II	Fins, conduction with heat source, unsteady state heat transfer.	6
III	Natural and forced convection, integral equation, analysis andanalogies.	6
IV	Transpiration cooling, ablation heat transfer, boiling, condensationand two phase flow mass transfer, cooling, fluidized bed combustion.	7
V	Heat pipes, Radiation, shape factor, analogy, shields.	7
VI	Radiation of gases, vapors and flames, Network method of analysisfor Radiation Problem.	7

Text Books

1	S. P. Sukhatme, "A Textbook on Heat Transfer", Universities Press, 4thEdition,2006.
2	Yunus. A. Cengel, "Heat Transfer – A Practical Approach", Tata McGraw Hill, 3rdEdition, 2006.
3	Incropera and Dewitt, "Fundamentals of Heat and Mass Transfer", Wileypublications, 2nd Edition, 2007.
4	P. K Nag, " Heat and Mass transfer", Tata McGraw Hill, 2nd Edition.
References	
1	Eckert and Drabe, "Analysis of Heat and Mass Transfer", McGraw Hill HigherEducation, 2003.
2	H. Schlichting , K. Gersten, " Boundary Layer Theory" Springer, 8th edition, 2000.
3	J. P. Holman, " Heat Transfer", McGraw Hill Book Company, New York, 1990.
4	Frank Kreith,"Principles of Heat Transfer", Harper and Row Publishers, New York, 1973.
5	Donald Q. Kern, " Process Heat Transfer", Tata McGraw Hill Publishing CompanyLtd., New Delhi, 1975.
6	R. C. Sachdeva,"Fundamentals of Engineering Heat and Mass Transfer", WileyEastern Ltd., India.
7	Latif M. Jiji, "Heat Conduction", Springer, 3rd edition, 2009.
Useful Links	
1	https://nptel.ac.in/courses/112/101/112101001/
2	https://nptel.ac.in/courses/112/105/112105271/

CO-PO Mapping

	Programme Outcomes (PO)					
	1	**2**	**3**	**4**	**5**	**6**
CO1	1		1			
CO2		2		2		
CO3		1				
CO4					2	

The strength of mapping is to be written as 1,2,3; Where, 1:Low, 2:Medium, 3:High
Each CO of the course must map to at least one PO.

Assessment

The assessment is based on MSE, ISE and ESE.
MSE shall be typically on modules 1 to 3.
ISE shall be taken throughout the semester in the form of teacher's assessment. Mode of assessment can be field visit, assignments etc. and is expected to map at least one higher order PO.
ESE shall be on all modules with around 40% weightage on modules 1 to 3 and 60% weightage on modules 4 to 6.
For passing a theory course, Min. 40% marks in (MSE+ISE+ESE) are needed and Min. 40% marks in ESE are needed. (ESE shall be a separate head of passing)

Walchand College of Engineering, Sangli

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AY 2024-25

Course Information	
Programme	M. Tech. (Thermal Engineering)
Class, Semester	First Year M. Tech., Sem I
Course Code	1TH551
Course Name	Thermodynamics and combustion Lab
Desired Requisites:	Requisite Courses: Basic Mathematics, Chemistry

Teaching Scheme		**Examination Scheme (Marks)**			
Practical	2Hrs/Week	**LA1**	**LA2**	**LA ESE**	**Total**
Interaction	-	30	30	40	100
		Credits: 1			

Course Objectives	
1	To learn about work and heat interactions, and balance of energy between system and its surroundings
2	To learn about application of law to various energy conversion devices
3	To evaluate the changes in properties of substances in various processes

Course Outcomes (CO) with Bloom's Taxonomy Level

At the end of the course, the students will be able to,

CO	**Course Outcome Statement/s**	**Bloom's Taxonomy Level**	**Bloom's Taxonomy Description**
CO1	Describe the experimental procedure of experiments in thermodynamics lab	II	Understanding
CO2	Solve field problems in Thermodynamics and Combustion by using different techniques.	III	Applying
CO3	Verify the concepts related to Thermodynamics and Combustion..	IV	Analyzing
CO4	Prepare and present a detailed technical report based on experiment /mini project work.	V	Evaluating

List of Experiments / Lab Activities

List of Experiments:

Course Contents:

Following practical's should be considered for ISE and ESE evaluation

Fuel testing

1. Test on Grease dropping point apparatus.
2. Test on Redwood Viscometer.
3. Determination of flash and fire point of a lubricating oil.
4. A test on Bomb calorimeter.

Thermodynamics Laws application

1. Mini steam power plant.
2. Cooling Tower.

3. Reciprocating compressor unit.

Text Books	
1	P. K. Nag "Thermodynamics", Tata McGraw Hill Publication, 20017, 6th Edition
2	Cengel and Boles, "Thermodynamics an engineering Approach", Tata McGraw-Hill publication, Revised 9th Edition.
References	
1	Sonntag, R. E, Borgnakke, C. and Van Wylen, G. J., 2003, 6th Edition, Fundamentals of Thermodynamics, John Wiley and Sons.
2	Jones, J. B. and Duggan, R. E., 1996, Engineering Thermodynamics, Prentice-Hall of India
3	Moran, M. J. and Shapiro, H. N., 1999, Fundamentals of Engineering Thermodynamics, John Wiley and Sons.
Useful Links	
1	https://archive.nptel.ac.in/courses/112/105/112105123/

CO-PO Mapping

	Programme Outcomes (PO)					
	1	**2**	**3**	**4**	**5**	**6**
CO1	3			1		
CO2			3			
CO3					3	
CO4						1

The strength of mapping is to be written as 1,2,3; Where, 1:Low, 2:Medium, 3:High
Each CO of the course must map to at least one PO.

Assessment

There are three components of lab assessment, LA1, LA2 and Lab ESE.
IMP: Lab ESE is a separate head of passing.(min 40 %), LA1+LA2 should be min 40%

Assessment	Based on	Conducted by	Typical Schedule (for 26-week Sem)	Marks
LA1	Lab activities, attendance, journal	Lab Course Faculty	During Week 1 to Week 8 Marks Submission at the end of Week 8	30
LA2	Lab activities, attendance, journal	Lab Course Faculty	During Week 9 to Week 16 Marks Submission at the end of Week 16	30
Lab ESE	Lab activities, journal/ performance	Lab Course Faculty and External Examiner as applicable	During Week 18 to Week 19 Marks Submission at the end of Week 19	40

Week 1 indicates starting week of a semester. Lab activities/Lab performance shall include performing experiments, mini-project, presentations, drawings, programming, and other suitable activities, as per the nature and requirement of the lab course. The experimental lab shall have typically 8-10 experiments and related activities if any.

Walchand College of Engineering, Sangli

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AY 2024-25

Course Information	
Programme	M. Tech. (Thermal Engineering)
Class, Semester	First Year M. Tech., Sem I
Course Code	1TH552
Course Name	Advanced Fluid Dynamics Lab
Desired Requisites:	Fluid Mechanics

Teaching Scheme		**Examination Scheme (Marks)**			
Practical	2Hrs/Week	**LA1**	**LA2**	**LA ESE**	**Total**
Interaction	-	30	30	40	100
		Credits: 1			

Course Objectives	
1	To provide hands-on experience with advanced experimental techniques used in fluid dynamics research and applications.
2	To develop skills in various flow visualization techniques to study fluid flow patterns and behaviors.
3	To enhance students' ability to use statistical and computational tools for analyzing fluid flow data.

Course Outcomes (CO) with Bloom's Taxonomy Level

At the end of the course, the students will be able to,

CO	**Course Outcome Statement/s**	**Bloom's Taxonomy Level**	**Bloom's Taxonomy Description**
CO1	Explain the working principles of various flow measurement instruments.	II	Understanding
CO2	Use flow visualization techniques to observe and analyze fluid flow patterns.	III	Applying
CO3	Compare experimental results with theoretical predictions to identify discrepancies and understand their causes.	IV	Analyzing
CO4	Evaluate the accuracy and reliability of experimental data and measurement techniques.	V	Evaluating

List of Experiments / Lab Activities

List of Experiments:

Course Contents:

1. Laminar and Turbulent Flow in Pipes
2. Flow Visualization Using Dye Injection
3. Measurement of Flow Rate Using Orifice and Venturi Meters
4. Jet Impact on Vanes
5. Cavitation in Fluid Flows
6. Flow Through Open Channels
7. Trial on Pelton Wheels
8. Trial on francis turbine

9. Trial on centrifugal pump	
Text Books	
1	Muralidhar and Biswas, Advanced Engineering Fluid Mechanics, , Alpha ScienceInternational, 2005
2	Irwin Shames, Mechanics of Fluids, , McGraw Hill, 2003
References	
1	Fox R.W., McDonald A.T , *Introduction to Fluid Mechanics*, John Wiley and Sons Inc,1985
2	Pijush K. Kundu, Ira M Kohen and David R. Dawaling, *Fluid Mechanics*, Fifth Edition, 2005
Useful Links	
1	https://youtu.be/H38vI93exns

CO-PO Mapping

	Programme Outcomes (PO)					
	1	**2**	**3**	**4**	**5**	**6**
CO1	3			1		
CO2			3			
CO3						
CO4					3	1

The strength of mapping is to be written as 1,2,3; Where, 1:Low, 2:Medium, 3:High
Each CO of the course must map to at least one PO.

Assessment

There are three components of lab assessment, LA1, LA2 and Lab ESE.
IMP: Lab ESE is a separate head of passing.(min 40 %), LA1+LA2 should be min 40%

Assessment	Based on	Conducted by	Typical Schedule (for 26-week Sem)	Marks
LA1	Lab activities, attendance, journal	Lab Course Faculty	During Week 1 to Week 8 Marks Submission at the end of Week 8	30
LA2	Lab activities, attendance, journal	Lab Course Faculty	During Week 9 to Week 16 Marks Submission at the end of Week 16	30
Lab ESE	Lab activities, journal/ performance	Lab Course Faculty and External Examiner as applicable	During Week 18 to Week 19 Marks Submission at the end of Week 19	40

Week 1 indicates starting week of a semester. Lab activities/Lab performance shall include performing experiments, mini-project, presentations, drawings, programming, and other suitable activities, as per the nature and requirement of the lab course. The experimental lab shall have typically 8-10 experiments and related activities if any.

Walchand College of Engineering, Sangli *(Government Aided Autonomous Institute)*					
AY 2024-25					
Course Information					
Programme		M. Tech. (Thermal Engineering)			
Class, Semester		First Year M. Tech., Sem I			
Course Code		1TH553			
Course Name		Advanced Heat Transfer Lab			
Desired Requisites:		Basic heat transfer			
Teaching Scheme		**Examination Scheme (Marks)**			
Practical	2Hrs/Week	**LA1**	**LA2**	**LA ESE**	**Total**
Interaction	-	30	30	40	100
		Credits: 1			

Course Objectives	
1	To provide hands-on experience with advanced experimental techniques used in heat transfer research and applications.
2	To investigate the fundamental mechanisms of heat transfer, including conduction, convection, and radiation.
3	To train students in the analysis and interpretation of experimental data in heat transfer.

Course Outcomes (CO) with Bloom's Taxonomy Level

At the end of the course, the students will be able to,

CO	**Course Outcome Statement/s**	**Bloom's Taxonomy Level**	**Bloom's Taxonomy Description**
CO1	Explain the theoretical background behind heat transfer measurements and calculations	II	Understanding
CO2	Conduct experiments to measure various heat transfer properties using appropriate instruments	III	Applying
CO3	Analyze experimental data to extract meaningful information about heat transfer characteristics	IV	Analyzing
CO4	Evaluate the performance and accuracy of different heat transfer measurement instruments and techniques	V	Evaluating

List of Experiments / Lab Activities

List of Experiments:

Course Contents:

1. Thermal Conductivity of Solids
2. Natural Convection
3. Forced Convection in a Pipe
4. Boiling Heat Transfer:
5. Double pipe heat exchanger
6. Shell and Tube Heat Exchanger

Text Books

1 S. P. Sukhatme, "A Textbook on Heat Transfer", Universities Press, 4thEdition,2006.

2	Yunus. A. Cengel, "Heat Transfer – A Practical Approach", Tata McGraw Hill, 3rd Edition, 2006.
References	
1	Eckert and Drabe, "Analysis of Heat and Mass Transfer", McGraw Hill HigherEducation, 2003.
2	H. Schlichting , K. Gersten, " Boundary Layer Theory" Springer, 8th edition, 2000.
Useful Links	
1	https://nptel.ac.in/courses/112/105/112105271/

CO-PO Mapping						
	Programme Outcomes (PO)					
	1	**2**	**3**	**4**	**5**	**6**
CO1	3			1		
CO2			3			
CO3						
CO4					3	1
The strength of mapping is to be written as 1,2,3; Where, 1:Low, 2:Medium, 3:High Each CO of the course must map to at least one PO.						

Assessment				
There are three components of lab assessment, LA1, LA2 and Lab ESE. IMP: Lab ESE is a separate head of passing.(min 40 %), LA1+LA2 should be min 40%				
Assessment	**Based on**	**Conducted by**	**Typical Schedule (for 26-week Sem)**	**Marks**
LA1	Lab activities, attendance, journal	Lab Course Faculty	During Week 1 to Week 8 Marks Submission at the end of Week 8	30
LA2	Lab activities, attendance, journal	Lab Course Faculty	During Week 9 to Week 16 Marks Submission at the end of Week 16	30
Lab ESE	Lab activities, journal/ performance	Lab Course Faculty and External Examiner as applicable	During Week 18 to Week 19 Marks Submission at the end of Week 19	40
Week 1 indicates starting week of a semester. Lab activities/Lab performance shall include performing experiments, mini-project, presentations, drawings, programming, and other suitable activities, as per the nature and requirement of the lab course. The experimental lab shall have typically 8-10 experiments and related activities if any.				

Walchand College of Engineering, Sangli *(Government Aided Autonomous Institute)*	
AY 2024-25	
Course Information	
Programme	M. Tech. (Thermal Engineering)
Class, Semester	First Year M. Tech., Sem I
Course Code	1TH511
Course Name	Nuclear Engineering
Desired Requisites:	Heat and Mass Transfer

Teaching Scheme		**Examination Scheme (Marks)**			
Lecture	3 Hrs/week	**MSE**	**ISE**	**ESE**	**Total**
Tutorial	-	30	20	50	100
		Credits: 3			

Course Objectives	
1	Demonstrate the basic concepts and processes taking place inside a nuclear reactor, such as nuclear fission, neutron production, scattering, diffusion, slowing down and absorption.
2	The student will also be familiar with concepts of reactor criticality, the relationship
3	The student will also be familiar with Time dependent (transient) behaviour of power reactor in nonsteady state operation and the means to control the reactor
4	The student will also be familiar with concepts of heat removal from reactor core, reactor safety and radiation protection.

Course Outcomes (CO) with Bloom's Taxonomy Level

At the end of the course, the students will be able to,

CO	**Course Outcome Statement/s**	**Bloom's Taxonomy Level**	**Bloom's Taxonomy Description**
CO1	Demonstrating concepts of heat removal from reactor core, reactor safety andradiation protection.	II	Understanding
CO2	Apply the basic concepts and processes taking place inside a nuclear reactor	III	Appling
CO3	Analysing time dependent (transient) behaviour of power reactor in nonsteady stateoperation and the means to control the reactor	IV	Analyzing
CO4	Evaluate regulatory challenges, public perception issues, and case studies in nuclear engineering.	V	Evaluating

Module	**Module Contents**	**Hours**
I	**Basics of nuclear fission and power from fission** Radioactivity, nuclear reactions, cross sections, nuclear fission, power from fission, conversion and breeding	6
II	**Neutron transport and diffusion** Neutron transport equation, diffusion theory approximation, Fick's law, solutionsto diffusion equation for point source, planar source, etc., energy loss in elastic collisions, neutron slowing down	7

III	**Multigrain, multiregional diffusion equation, concept of criticality** Solution of multigrain diffusion equations in one region and multiregional reactors, concept of criticality of thermal reactors	7
IV	**Reactor kinetics and control** Derivation of point kinetics equations, in hour equation, solutions for simple cases of reactivity additions, fission product poison, reactivity coefficients	7
V	**Heat removal from reactor core** Solution of heat transfer equation in reactor core, temperature distribution,critical heat flux	7
VI	**Reactor safety, radiation protection** Reactor safety philosophy, defence in depth, units of radioactivity exposure, radiation protection standards	6

	Text Books
1	Introduction to Nuclear Engineering (3rd Edition) by John R. Lamarsh, Anthony J.Barrata, Prentice Hall, (2001)
	References
1	Introduction to Nuclear Reactor Theory, by John R. Lamarsh, Addison-Wesley, 1966)
2	Nuclear Reactor Analysis, by James J. Duderstadt and Lewis J. Hamilton, John Wiley(1976)
	Useful Links
1	https://nptel.ac.in/courses/112/103/112103243/
2	https://nptel.ac.in/courses/112/101/112101007/

CO-PO Mapping

	Programme Outcomes (PO)					
	1	**2**	**3**	**4**	**5**	**6**
CO1	1					
CO2	1					
CO3		1	1			
CO4				1		

The strength of mapping is to be written as 1,2,3; Where, 1:Low, 2:Medium, 3:High
Each CO of the course must map to at least one PO.

Assessment

The assessment is based on MSE, ISE and ESE.
MSE shall be typically on modules 1 to 3.
ISE shall be taken throughout the semester in the form of teacher's assessment. Mode of assessment can be field visit, assignments etc. and is expected to map at least one higher order PO.
ESE shall be on all modules with around 40% weightage on modules 1 to 3 and 60% weightage on modules 4 to 6.
For passing a theory course, Min. 40% marks in (MSE+ISE+ESE) are needed and Min. 40% marks in ESE are needed. (ESE shall be a separate head of passing)

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Course Information

Programme	M. Tech. (Thermal Engineering)
Class, Semester	First Year M. Tech., Sem I
Course Code	1TH512
Course Name	Design of Thermal Turbo Systems
Desired Requisites:	Fluid and turbo machinery

Teaching Scheme		**Examination Scheme (Marks)**			
Lecture	3 Hrs/week	**MSE**	**ISE**	**ESE**	**Total**
Tutorial	-	30	20	50	100
		Credits: 3			

Course Objectives

1	Recognize typical designs of turbo machines and Explain the working principles of turbomachines and apply it to various types of machines
2	Determine the velocity triangles in turbomachinery stages operating at design and off-design conditions.
3	Perform the preliminary design of turbomachines (Fans compressors) on a 1-D basis
4	Use design parameters for characterizing turbomachinery stages and determine the off-design behavior of turbines and compressors and relate it to changes in the velocity triangles • Explainand understand how the flow varies downstream of a turbomachinery blade row
5	Recognize relations between choices made early in the turbomachinery design process and the final components and operability
6	Explain the limits of safe operation of compressors

Course Outcomes (CO) with Bloom's Taxonomy Level

At the end of the course, the students will be able to,

CO	Course Outcome Statement/s	Bloom's Taxonomy Level	Bloom's Taxonomy Description
CO1	Explain the different types of turbo machinery and working principle of turbomachinery	II	Understanding
CO2	Apply the basics of turbo systems, the energy transformation in them.	III	Applying
CO3	Design of centrifugal and axial turbo systems.	IV	Analyzing
CO4	Evaluate performance of turbo systems.	V	Evaluating

Module	Module Contents	Hours
I	**Introduction to Turbomachines:** Turbines Pumps and Compressors Fans and Blowers Compressible Flow Machines Incompressible Flow Machines Turbine, Compressor and Fan Stages Extended Turbomachines Axial Stages Radial Stages Mixed Flow Stages Impulse Stages Reaction Stages Variable Reaction Stages Multistage Machines Stage Velocity Triangles Design Conditions Off-design Conditions Applications	7
II	**Fluid Dynamic Principles:** Equations of Motion (in Cartesian, Cylindrical and Natural Coordinate system) Further notes on Energy Equation, Isentropic Flow through Blade passages, High	7

	speed flows, Aerofoil Blades.	
III	**Dimensional Analysis and Performance Parameters**: Units and Dimensions, Buckingham’s Pi theorem, Principle of similarity, Incompressible flow machines, Compressible flow machines, Performance of Compressors, Fans and Blowers.	7
IV	**Compressor:** Axial and Centrifugal compressor, Elements of centrifugal compressor stage, stage velocity triangles, Enthalpy – Entropy diagram, Stage losses and Efficiency, Performance characteristics	7
V	**Axial Fans and Propellers:** Fan Applications, Axial fans, Fan stage parameters, types of Axial fan stages, Propellers, Performance of Axial Fans.	6
VI	**Centrifugal Fans and Blowers:** Centrifugal Fan stage parameters, Design Parameters, Losses, Fan Drives, Bearings and Noise, Dust Erosion of Fans	6
	Text Books	
1	S M Yahya , “ Turbines, Compressors and Fans, McGrawHill Publication	
2	Shepherd, D.G., “Principles of Turbomachinery”, Macmillan, 1969.	
	References	
1	Bruneck, Fans, Pergamom Press, 1973	
2	Earl Logan, Jr., Handbook of Turbomachinery, Marcel Dekker Inc., 1992	
3	Dixon, S.I., “Fluid Mechanics and Thermodynamics of Turbomachinery”, Pergamon Press, 1990.	
4	Gopalakrishnan .G and Prithvi Raj .D, “A Treatise on Turbomachines”, Scifech Publications (India) Pvt. Ltd., 2002.	
	Useful Links	
1	https://nptel.ac.in/courses/112/105/112105206/	
2	https://nptel.ac.in/courses/101/101/101101058/	

CO-PO Mapping						
	Programme Outcomes (PO)					
	1	**2**	**3**	**4**	**5**	**6**
CO1		2				
CO2	1		2			1
CO3		1	2		3	
			2	3		

The strength of mapping is to be written as 1,2,3; Where, 1:Low, 2:Medium, 3:High
Each CO of the course must map to at least one PO.

Assessment
The assessment is based on MSE, ISE and ESE. MSE shall be typically on modules 1 to 3. ISE shall be taken throughout the semester in the form of teacher’s assessment. Mode of assessment can be field visit, assignments etc. and is expected to map at least one higher order PO. ESE shall be on all modules with around 40% weightage on modules 1 to 3 and 60% weightage on modules 4 to 6. For passing a theory course, Min. 40% marks in (MSE+ISE+ESE) are needed and Min. 40% marks in ESE are needed. (ESE shall be a separate head of passing)

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Course Information	
Programme	M. Tech. (Thermal Engineering)
Class, Semester	First Year M. Tech., Sem I
Course Code	1TH513
Course Name	Gas Turbines
Desired Requisites:	Thermodynamics, Fluid Mechanics

Teaching Scheme		**Examination Scheme (Marks)**			
Lecture	3 Hrs/week	**MSE**	**ISE**	**ESE**	**Total**
Tutorial	-	30	20	50	100
		Credits: 3			

Course Objectives	
1	To enable the students to analyze and solve gas turbine related problems by applyingprinciples of mathematics, science and engineering.
2	To prepare students to use modern tools, techniques and skills to fulfill industrial needsrelated to gas turbine systems.
3	To train students with effective communication skills to demonstrate gas turbine theories.
4	To develop skills in the analysis of gas turbine systems in research or design.
5	To develop a professional approach to lifelong learning in the gas turbine to include theawareness of social and environment issues associated with engineering practices.

Course Outcomes (CO) with Bloom's Taxonomy Level

At the end of the course, the students will be able to,

CO	**Course Outcome Statement/s**	**Bloom's Taxonomy Level**	**Bloom's Taxonomy Description**
CO1	Explain the role of key components such as the compressor, combustor, and turbine in a gas turbine engine.	II	Understanding
CO2	Apply knowledge of mathematics, science, and engineering for designing gasturbine systems.	III	Applying
CO3	Analyse different gas turbine systems and their characteristics	IV	Analyzing
CO4	Evaluate the performance of gas turbine systems.	V	Evaluating

Module	**Module Contents**	**Hours**
I	**Gas Turbine Plant:** Historical review. Thermodynamic analysis of practical gas turbine cycles. The turboprop engine. The compressor, combustor, turbine and exhaust nozzle characteristics. Performance characteristics of the stationary andturboprop and turbojet engine. The turbojet engine components. Specific thrust and overall efficiency. Static and flight performance at the design point. Fundamentals of rotating machines. Impulse and reaction machines. The centrifugal compressor: Works done and pressure rise. Design of centrifugal compressor, surge & stall.	7
II	**Centrifugal Compressors:**	7

	Principal of operation, work done and pressure rise. Vane-less space, slip factor, power input factor and Mach number at intake to impeller	

III	**Axial Flow Compressor:** Principle of operation, velocity triangles. Design procedure for single and multistage compressors. Three dimensional effect compressor performance. Description and problems of transonic and supersonic compressors.	7
IV	**Combustion in Gas Turbine:** Problem to be faced in the design of gas turbine combustion systems. Fuel injection system. Combustion chamber designs. Pressure loss. Temperature distribution, Reaction time, Flame stabilization.	7
V	**Turbine Characteristics:** Off design performance of gas turbine plant, matching of the engine components, equilibrium running diagram. Specific thrust and specific fuel consumption in such cases for stationary turbojet and turboprop units.	6
VI	**Materials used in Gas Turbine**: Factors influencing selection of materials, materials used for different component like compressor component, combustion chamber, disc and rotors, turbine blades, nozzle, guide vanes, turbine casing and heat exchanges, Environmental Considerations and Applications, Failure analysis.	6

Text Books	
1	V. Ganesan "Gas Turbine" Tata McGraw-Hill Education, 2ndedi. ,2003

References	
1	Cohan, Rogers "Gas Turbine" Person, 5th edition. ,2001
2	Dr.Meherwan P. Boyce, P.E "Gas Turbine Engineering" Handbook, 3rdedition, 2011.
3	Earl Logan "Handbook of Turbomachinery" CRC press, 2003.

Useful Links	
1	https://nptel.ac.in/courses/112/103/112103262/

CO-PO Mapping

	Programme Outcomes (PO)					
	1	**2**	**3**	**4**	**5**	**6**
CO1		2				
CO2	2				2	
CO3	2			2	2	
CO4	2					2

The strength of mapping is to be written as 1,2,3; Where, 1:Low, 2:Medium, 3:High
Each CO of the course must map to at least one PO.

Assessment

The assessment is based on MSE, ISE and ESE.
MSE shall be typically on modules 1 to 3.
ISE shall be taken throughout the semester in the form of teacher's assessment. Mode of assessment can be field visit, assignments etc. and is expected to map at least one higher order PO.
ESE shall be on all modules with around 40% weightage on modules 1 to 3 and 60% weightage on modules 4 to 6.
For passing a theory course, Min. 40% marks in (MSE+ISE+ESE) are needed and Min. 40% marks in ESE are needed. (ESE shall be a separate head of passing)

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Course Information			
Programme	M. Tech. (Thermal Engineering)		
Class, Semester	First Year M. Tech., Sem I		
Course Code	1TH514		
Course Name	Design of Hydro Turbo machines		
Desired Requisites:	Turbo Machinery		

Teaching Scheme		**Examination Scheme (Marks)**			
Lecture	3 Hrs/week	**MSE**	**ISE**	**ESE**	**Total**
Tutorial	-	30	20	50	100
		Credits: 3			

Course Objectives	
1	To enable the students to analyse and solve hydrodynamic machine related problems byapplying principles of mathematics, science and engineering.
2	To prepare students to handle various strategic issues related to hydrodynamic machines suchas turbines, pumps etc.
3	To train students with effective communication skills to demonstrate hydrodynamic theories.
4	To develop skills in designing the hydrodynamic machine component. To develop a professional approach to lifelong learning in the hydrodynamic machine to include the awareness of social and environment issues associated with engineering practices.

Course Outcomes (CO) with Bloom's Taxonomy Level

At the end of the course, the students will be able to,

CO	**Course Outcome Statement/s**	**Bloom's Taxonomy Level**	**Bloom's Taxonomy Description**
CO1	Describe different types of hydrodynamic machines and its components.	II	Understanding
CO2	Apply knowledge of mathematics, science, and engineering for the needsin hydrodynamic machine design.	III	Applying
CO3	Carry out analysis and interpret results.	IV	Analyzing
CO4	Evaluate the performance of hydro turbines and pumps	V	Evaluating

Module	**Module Contents**	**Hours**
I	**Introduction to Hydrodynamic Machines** Classification of turbines and various forms of turbine runners, Impulse turbines; general theory of impulse machines; performance characteristics, Reaction turbines; general theory of reaction machines;performance characteristics, types; Francis and Kaplan turbines; theory of cavitation flows in hydrodynamic runners. Hydrodynamic pumps; classification of pumps and various forms of pump impellers; general theory of centrifugal pumps; performance characteristics	7
II	Design of centrifugal pumps, selection of speed, determination of impeller inlet and outlet dimensions, meridional geometry inlet and	6

	exit blade angles, blade geometry, mixed flow pumps, elementarypump, design of twisted blade, design of volute, vane diffuser and return passage, suction spiral.	
III	Axial flow pumps, selection of speed, pump casing geometry hub diameter, number of blades and cascade solidity, selection of blade geometry on different flow surfaces, diffuser design.	6
IV	Introduction to hydraulic turbine design, Type series and diameter series, selection of type and diameter, Reaction turbine runner spaces, meridional velocity field, elementary turbines, Hydraulic design ofFrancis turbine, Choice of basic parameters, Inlet and Outlet edges of runner blade, blade profiles on flow surfaces, shape of blade duct-velocity diagrams on different flow surfaces, certain guide lines to finalize the runner design, Guide wheel, Vane geometry and torque on controlling mechanism, Discharge and circulation, spiral, speedring, draft tube.	8
V	Hydraulic design of axial turbine runners, characteristics of some aerofoils, meridional flow field, blade geometry on each flow surface, procedure to finalize the runner design.	6
VI	Hydraulic design of pelton wheel, number of nozzles and their diameter, runner diameter, number of buckets, positioning of buckets, bucket geometry and size,- needle regulator, deflector.	7

	Text Books
1	Nechleba M., “Hydraulic Turbine their Design and Equipments”, Constable & Co., 1957.
2	Lazarkieniz & Troskolanrkis, “Impeller Pumps”, Pergamon Press, 1st edition, 1965.
3	Robinson J.A., “Hydraulic Engineering”, Jaico Publishing House, Bombay, 2nd Edition,1998

	References
1	Andre Kovats, “Design and Performance of Centrifugal & Axial flow pumps & Compressors”, Pergamon, 1st edition. 1964.
2	Stapanoff, A.J., “Centrifugal & Axial Flow Pumps”, John Wiely, Rev ed, 1993.
3	Editor Brown, J.G., “Hydroelectric Engineering Practice”, Vol-I & II, 1st, edition,1958.

	Useful Links
1	https://nptel.ac.in/courses/112/105/112105206/

CO-PO Mapping

	Programme Outcomes (PO)					
	1	**2**	**3**	**4**	**5**	**6**
CO1	1	1	1	1	2	1
CO2		2	1	3	3	2
CO3			2	3	2	2
CO4					2	

The strength of mapping is to be written as 1,2,3; Where, 1:Low, 2:Medium, 3:High
Each CO of the course must map to at least one PO.

Assessment
The assessment is based on MSE, ISE and ESE. MSE shall be typically on modules 1 to 3. ISE shall be taken throughout the semester in the form of teacher's assessment. Mode of assessment can be field visit, assignments etc. and is expected to map at least one higher order PO. ESE shall be on all modules with around 40% weightage on modules 1 to 3 and 60% weightage on modules 4 to 6. For passing a theory course, Min. 40% marks in (MSE+ISE+ESE) are needed and Min. 40% marks in ESE are needed. (ESE shall be a separate head of passing)

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AY 2024-25

Course Information

Programme	M. Tech. (Thermal Engineering)
Class, Semester	First Year M. Tech., Sem I
Course Code	1TH515
Course Name	Air-Conditioning System Design
Desired Requisites:	Thermodynamics, Fluid Mechanics, Heat Transfer, Refrigeration and Air-Conditioning.

Teaching Scheme		**Examination Scheme (Marks)**				
Lecture	3 Hrs/week	**MSE**	**ISE**	**ESE**		**Total**
Tutorial	-	30	20	50		100
		Credits: 3				

Course Objectives

1	To enable the students to analyze and solve air conditioning related problems by applyingprinciples of mathematics, science and engineering.
2	To prepare students to use modern tools, techniques and skills to fulfil industrial needsrelated to low temperature systems.
3	To train students with effective communication skills to demonstrate air conditioningtheories.
4	To develop skills in the analysis of air conditioning systems in research or design.
5	To develop a professional approach to lifelong learning in the air conditioning to includethe awareness of social and environment issues associated with engineering practices

Course Outcomes (CO) with Bloom's Taxonomy Level

At the end of the course, the students will be able to,

CO	**Course Outcome Statement/s**	**Bloom's Taxonomy Level**	**Bloom's Taxonomy Description**
CO1	Describe the principles behind psychrometrics and how they influence air-conditioning system design.	II	Understanding
CO2	Apply knowledge of mathematics, science and engineering for the needs inair-conditioning.	III	Applying
CO3	Analyze different Air-Conditioning systems and their characteristics.	IV	Analyzing
CO4	Evaluate the performance and interpret the report in the field of Air-Conditioning.	V	Evaluating

Module	**Module Contents**		**Hours**

I	**Psychrometry.** Moist Air properties, use of Psychometric Chart, Various Psychometrics processes, Air Washer, Adiabatic Saturation. Fundamental properties of air and water vapour mixtures. - Definitions, equations and explanations, psychometric table and charts, Enthalpy deviation curve, psychometricprocesses and their analysis, SHF, effective surface temperature and bypassfactor. Air quality required. Analysis of combination of processespsychometric system. Load Analysis: Inside design conditions, outsidedesign conditions, sensible heat load and latent heat loads, heat gains from infiltration ventilation, solar radiation from walls, occupants and othersources. Heating load, Load estimation chart.	7
II	**Summer and Winter Air Conditioning** Air conditioning processes-RSHF, summer Air conditioning, Winter Air conditioning, Applications with specified ventilation air quantity- Use of ERSHF , Application with low latent heat loads and high latent heat loads, performance and selection.	7
III	**Heating & Cooling Load Calculations** Introduction, Health & comfort criteria, thermal comfort, air quality, estimating heat loss & heat gain, design conditions, thermal transmission, infiltration & ventilation loads, components of cooling load, internal loads, solar load through transparent surfaces, opaque surfaces, problems. Selection of components and system performance.	7
IV	**Air Distribution** Flow through Ducts, Static & Dynamic Losses, Air outlets, Duct Design–Equal Friction Method, Duct Balancing, Indoor Air Quality, Thermal Insulation, Fans & Duct System Characteristics, Fan ArrangementVariable Air Volume systems, Air Handling Units and Fan Coil units.	6
V	**Air Handling Equipments** Fans, air conditioning apparatus, unitary equipment, accessory equipment, Classification – all air- system, air water system, heat recovery system, radiation panel system, heat pump , air washers. noise control.	6
VI	**Industrial Applications of A.C** Major uses of air conditioning of medium sized & large buildings, industrial air conditioning, residential air conditioning, air conditioning of vehicles, food storage & distribution, food processing, pharmaceutical, chemical & process industry, special applications of air conditioning.	7

Text Books	
1	Manohar Prasad, “Refrigeration & Air Conditioning”, New Age Publishers.
2	Stoecker, “Refrigeration & Air Conditioning”, McGraw Hill, 1992.
3	Arora C.P., “Refrigeration & Air Conditioning”, Tata McGraw Hill, 1985.
4	“Refrigeration and air-conditioning”, ARI, Prentice Hall, New Delhi, 1993.
5	Stoecker, “Design of Thermal Systems”, McGraw Hill, 1992.
References	
1	“Handbook of air-conditioning system design”, Carrier Incorporation, McGraw HillBook Co., U.S.A, 1965.
2	ASHRAE Handbook.: HVAC Systems and Equipment, 1996.
3	Hainer R.W., “Control Systems for Heating, Ventilation and Air-Conditioning”, VanNostrand
4	Norman C. Harris, “Modern Air Conditioning”, New York, McGraw-Hill,1974.
5	Jones W.P., “Air Conditioning Engineering”, Edward Arnold Publishers Ltd.,London,1984.
Useful Links	
1	https://youtu.be/e2IryaMQQ6A
2	https://youtu.be/YUgN5D-bmpg
3	https://youtu.be/Dj8ATzgrxyA
4	https://youtu.be/nvUhiXD63Eg

CO-PO Mapping

	Programme Outcomes (PO)					
	1	**2**	**3**	**4**	**5**	**6**
CO1		2				
CO2	1	2	3	4	5	6
CO3			3			
CO4			2	2		

The strength of mapping is to be written as 1,2,3; Where, 1:Low, 2:Medium, 3:High
Each CO of the course must map to at least one PO.

Assessment

The assessment is based on MSE, ISE and ESE.
MSE shall be typically on modules 1 to 3.
ISE shall be taken throughout the semester in the form of teacher’s assessment. Mode of assessment can be field visit, assignments etc. and is expected to map at least one higher order PO.
ESE shall be on all modules with around 40% weightage on modules 1 to 3 and 60% weightage on modules 4 to 6.
For passing a theory course, Min. 40% marks in (MSE+ISE+ESE) are needed and Min. 40% marks in ESE are needed. (ESE shall be a separate head of passing)

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Course Information	
Programme	M. Tech. (Theraml Engineering)
Class, Semester	First Year M. Tech., Sem - I
Course Code	1TH516
Course Name	Design of Solar and Wind System
Desired Requisites:	Energy engineering

Teaching Scheme		**Examination Scheme (Marks)**			
Lecture	3 Hrs/week	**MSE**	**ISE**	**ESE**	**Total**
Tutorial	0 Hrs/week	30	20	50	100
		Credits: 3			

Course Objectives	
1	To develop a comprehensive technological understanding in solar PV system components
2	To provide in-depth understanding of design parameters to help design and simulate the performance of a solar PV power plant
3	Learn principles and operational features of wind machines, wind data performance

Course Outcomes (CO) with Bloom's Taxonomy Level

At the end of the course, the students will be able to,

CO	**Course Outcome Statement/s**	**Bloom's Taxonomy Level**	**Bloom's Taxonomy Description**
CO1	Explain the basics of solar energy conversion systems	II	Understanding
CO2	Apply knowledge of solar irradiance and site assessment techniques to determine the feasibility of solar PV installations	III	Applying
CO3	Analyze a standalone PV system	IV	Analyzing
CO4	Evaluate different wind energy conversion systems	V	Evaluating

Module	**Module Contents**	**Hours**
I	Energy scenario, Man and energy, World's production of commercial energy sources, India's production and reserves, Energy alternatives, The solar energy option	6
II	Thermal applications, Water heating, Space heating, Space cooling and refrigeration, Power generation, Distillation, Drying and Cooking, Concentrating collector, Central receiver system	6
III	Liquid flat plate collector, Performance analysis, Collection efficiency factor, Selective surfaces, Evacuated tube collector, BNL, Polymer and concrete collector, Solar air collector, types, performance analysis, Air heater with fins,	7
IV	Thermal energy storages, Sensible and latent heat storage, Solar ponds, Performance analysis, operational problems, Other solar pond concepts, Photovoltaic conversion, Performance characteristics, Commercial solar cell, cost and applications, prospects of PV cell for India	7
V	Wind energy fundamentals and applications, Merits, Limitations, Nature and origin of wind, Wind turbine theory, Power of wind turbine for given incoming wind velocity Vi, Wind to electric energy conversion system	7
VI	Classification and development of wind machines, Multi bladed type, Propeller type, wind machines, Wind data performance calculation, Concluding remarks, prospects of wind energy for India	7

Textbooks	
1	S. Rao Dr. B. B. Parulekar, "Energy Technology – Nonconventional, Renewable & Conventional", Khanna Publishers
2	S.P. Sukhatme and J K Nayak, " Solar Energy" McGraw Hill Education
3	B. S. Mangal, " Solar Power Engineering", Tata McGraw Hill, New Delhi 1990

4	Spera D. A. 1994, “Wind Turbine Technology, Fundamentals of concept in wind turbine Engg.” ASME ebook
References	
1	Culp, Archie W, “Principles of Energy Conversion”, McGraw Hill Book Company
2	Rabl. A. 1985, “Active solar collectors and their applications” Oxford University press
3	John A Duffie, W. A. Beckman, “Solar Engineering of Thermal Processes”, John Wiley and Sons INC
4	Gary L. Johnson, “Wind Energy Systems”, Prentice Hall New Jersey
5	Sathyajith, Mathew, “Wind Energy Fundamentals, Resource Analysis and Economics”, springer verlag Berlin
6	Kloeffler R.G, Sitz E.L (1946), “Electric Energy from Winds” Kansas State College of Engg.,ManhattanKans
Useful Links	
1	https://nptel.ac.in/courses/103/103/103103206/

CO-PO Mapping

	Programme Outcomes (PO)					
	1	**2**	**3**	**4**	**5**	**6**
CO1	1	1		2		
CO2			2			
CO3					2	
CO4		2		2		

The strength of mapping is to be written as 1,2,3; Where, 1:Low, 2:Medium, 3:High
Each CO of the course must map to at least one PO.

Assessment

The assessment is based on MSE, ISE and ESE.
MSE shall be typically on modules 1 to 3.
ISE shall be taken throughout the semester in the form of teacher’s assessment. Mode of assessment can be field visit, assignments etc. and is expected to map at least one higher order PO.
ESE shall be on all modules with around 40% weightage on modules 1 to 3 and 60% weightage on modules 4 to 6.
For passing a theory course, Min. 40% marks in (MSE+ISE+ESE) are needed and Min. 40% marks in ESE are needed. (ESE shall be a separate head of passing)

Walchand College of Engineering

(Government Aided Autonomous Institute)

Vishrambag, Sangli-416415

Course Content for F. Y. M. Tech. (Thermal Engineering)

Semester-II

2024-25

Walchand College of Engineering, Sangli

(Government Aided Autonomous Institute)

AY 2024-25

Course Information	
Programme	M. Tech. (Thermal Engineering)
Class, Semester	First Year M. Tech., Sem II
Course Code	1TH521
Course Name	Steam Engineering
Desired Requisites:	Basic Heat Transfer

Teaching Scheme		**Examination Scheme (Marks)**			
Lecture	3 Hrs/week	**MSE**	**ISE**	**ESE**	**Total**
Tutorial	-	30	20	50	100
		Credits: 3			

Course Objectives	
1	To analyze different types of steam cycles and estimate efficiencies in a steam powerplant.
2	To design pipe insulation through proper selection of materials with the help of basic heattransfer theory.
3	To access boiler performance for different loading conditions.
4	To develop a professional approach for lifelong learning in steam engineering to includethe awareness of social and environmental issues associated with engineering practices.

Course Outcomes (CO) with Bloom's Taxonomy Level

At the end of the course, the students will be able to

CO	**Course Outcome Statement/s**	**Bloom's Taxonomy Level**	**Bloom's Taxonomy Description**
CO1	Explain working of different boilers and significance of mountings and accessories. and to use techniques, skills, and modern engineering tools necessary for boiler performance assessment	II	Understanding
CO2	Calculate the efficiency of steam cycles using thermodynamic equations.	III	Applying
CO3	Analyze a thermal system for different sources of waste heat	IV	Analyzing
CO4	Suggest suitable controls and instrumentation for effective monitoringof the process	V	Evaluating

Module	**Module Contents**	**Hours**
I	Introduction Fundamentals of steam generation, Quality of steam, Use of steam table, Mollier Chart Boilers, Types, Mountings and Accessories, Combustion in boilers, Determination of adiabatic flame temperature, quantity of flue gases, Feed Water and its quality, Blow down; IBR, Boiler standards.	7
II	Piping & Insulation Water Line, Steam line design and insulation; Insulation-types and application, Economic thickness of insulation, Heat savings and application criteria, Refractory-types, selection and application of refractory, Heat loss.	7

III	Steam Systems Assessment of steam distribution losses, Steam leakages, Steam trapping, Condensate and flash steam recovery system, Steam Engineering Practices; Steam Based Equipment's Systems.	7
IV	Boiler Performance Assessment Performance Test codes and procedure, Boiler Efficiency, Analysis of losses; performance evaluation of accessories; factors affecting boilerperformance.	7
V	Energy Conservation and Waste Minimization Energy conservation options in Boiler; waste minimization, methodology; economic viability of waste minimization.	6
VI	Instrumentation & Control Process instrumentation; control and monitoring. Flow, pressure andtemperature measuring and controlling instruments, its selection.	6

Text Books	
1	T. D. Estop, A. McConkey, Applied Thermodynamics, Parson Publication.
2	Domkundwar; A Course in Power Plant Engineering; Dhanapat Rai and Sons.
3	Yunus A. Cengel and Boles, "Engineering Thermodynamics ", Tata McGraw-Hill Publishing Co. Ltd.
References	
1	Energy Performance Assessment for Equipment & Utility Systems; Bureau of Energy Efficiency.
2	P. Chatopadhyay; Boiler Operation Engineering: Questions and Answes; TataMcGrawHill Education Pvt Ltd, N Delhi
3	Edited by J. B. Kitto& S C Stultz; Steam: Its Generation and Use; The Babcock and Wilcox Company.
Useful Links	
1	https://nptel.ac.in/courses/112/107/112107216/

CO-PO Mapping						
	Programme Outcomes (PO)					
	1	**2**	**3**	**4**	**5**	**6**
CO1	1	2	2			
CO2	1		3	3	2	
CO3	1		3	3	2	
CO4	1	1	2	2	2	2

The strength of mapping is to be written as 1,2,3; Where, 1:Low, 2:Medium, 3:High
Each CO of the course must map to at least one PO.

Assessment
The assessment is based on MSE, ISE and ESE. MSE shall be typically on modules 1 to 3. ISE shall be taken throughout the semester in the form of teacher’s assessment. Mode of assessment can be field visit, assignments etc. and is expected to map at least one higher order PO. ESE shall be on all modules with around 40% weightage on modules 1 to 3 and 60% weightage on modules 4 to 6. For passing a theory course, Min. 40% marks in (MSE+ISE+ESE) are needed and Min. 40% marks in ESE are needed. (ESE shall be a separate head of passing)

Walchand College of Engineering, Sangli *(Government Aided Autonomous Institute)*						
AY 2024-25						
Course Information						
Programme		M. Tech. (Thermal Engineering)				
Class, Semester		First Year M. Tech., Sem II				
Course Code		1TH522				
Course Name		Computational Techniques in Fluid Flow and Heat Transfer				
Desired Requisites:		Fluid Mechanics, Thermodynamics, Mathematics, Heat Transfer, Numerical methods				
Teaching Scheme		**Examination Scheme (Marks)**				
Lecture	3 Hrs/week	**MSE**	**ISE**	**ESE**	**Total**	
Tutorial	-	30	20	50	100	
		Credits: 3				

Course Objectives	
1	Enable the students to analyse and solve fluid related problems by applying principles of mathematics, science and engineering.
2	Prepare students to use modern tools, techniques and skills to fulfill industrial needs related to computational techniques in fluid flow and heat transfer.
3	Train students with effective communication skill to demonstrate computational theories.
4	Develop skills in the analysis of fluid systems with mathematical modeling for applications of computers in research or design.
5	Develop a professional approach to lifelong learning in the numerical analysis to include the awareness of social and environment issues associated with engineering practices.

Course Outcomes (CO) with Bloom's Taxonomy Level

At the end of the course, the students will be able to,

CO	**Course Outcome Statement/s**	**Bloom's Taxonomy Level**	**Bloom's Taxonomy Description**
CO1	Explain prediction methods, PDEs and numerical methods.	II	Understanding
CO2	Apply the FDM and FVM techniques to solve Fluid and Thermal related problems.	III	Applying
CO3	Analyse boundary conditions, solution methods and schemes used in fluid flowand heat transfer problems.	IV	Analyzing
CO4	Compare FVM with other methods (e.g., Lattice Boltzmann Method) for simulating multiphase flows in terms of accuracy, stability, and computational cost.	V	Evaluating

Module	**Module Contents**	**Hours**
I	**Comparison of experimental, theoretical and numerical approaches:** Partial differential equations - Physical and mathematical classification -Parabolic, Elliptical and Hyperbolic equations. Computational economy, Numerical stability, Selection of numerical methods, validation of numerical results: Numerical error and accuracy – Round off error, accuracy of numerical results – Iterative convergence – Condition for convergence, Rate of convergence, under-relaxation and over relaxation, Termination of iteration: Tridiagonal Matrixalgorithm.	7

II	**Finite Difference method:** Discretization – Converting Derivatives to discrete Algebraic Expressions, Taylor's series approach, polynomial fitting approach, Discretization error.	6
III	**Heat conduction** Steady one-dimensional conduction in Cartesian and cylindrical co-ordinates, handling of boundary conditions: Two dimensional steady state conduction problems in Cartesian and cylindrical co-ordinates – point by point and line by line method of Solution: Dealing of Dirichlet, Neumann and Robbins type boundary conditions- Formation of discretized equations for regular boundaries, irregular boundaries and interfaces	7
IV	**One dimensional, two dimensional and three dimensional transient heat conduction problems in Cartesian and cylindrical co-ordinates:** Explicit, Implicit, Crank Nicholson and ADI methods- stability of each system Conservation form and conservative property of partial differential equations and finite difference equations- Consistency, stability and convergence for marching problems Discrete perturbation stability analysis- Fourier or Von Neumann stability analysis.	7
V	**Finite volume method 1:** Discretization of governing equations - Diffusion and convection-diffusion problems steady one-dimensional convection and diffusion, upwind, hybrid and power-law schemes:	6
VI	**Finite volume method 2:** Discretization equation for two-dimensions: False diffusion, calculation for the Flow Field- Stream function- vortices approach, SIMPLE, SIMPLER, SIMPLEC and QUICK Algorithms. Numerical Marching Techniques. Two dimensional parabolic flows with heat; Grid generation methods, Adaptive grids.	7

CO-PO Mapping

Programme Outcomes (PO)

Text Books

1	S.V. Patankar, "Numerical Fluid Flow & Heat transfer", Hemisphere Publishing Corp., 1980.
2	T. Sundernajan, K. Muralidhar, "Computational Fluid Flow and Heat Transfer", Narosa, 2nd edition, Reprint 2011

References

1	H. K. Versteeg and W. Malalasekera, "An Introduction to Computational Fluid Dynamics", Longman Scientific and Technical, 1st edition, 1995.
2	Hoffman Klaus, "Computational Fluid Dynamics", Vol-1 & 2, A Publication of Engineering Education System, Wichita Kansas, USA, 2000

Useful Links

1	https://nptel.ac.in/courses/112/104/112104302/
2	https://nptel.ac.in/courses/112/108/112108091/

	1	**2**	**3**	**4**	**5**	**6**
CO1	2	2			2	
CO2	2				2	
CO3	2			2		2
CO4					2	

The strength of mapping is to be written as 1,2,3; Where, 1:Low, 2:Medium, 3:High
Each CO of the course must map to at least one PO.

Assessment
The assessment is based on MSE, ISE and ESE. MSE shall be typically on modules 1 to 3. ISE shall be taken throughout the semester in the form of teacher's assessment. Mode of assessment can be field visit, assignments etc. and is expected to map at least one higher order PO. ESE shall be on all modules with around 40% weightage on modules 1 to 3 and 60% weightage on modules 4 to 6. For passing a theory course, Min. 40% marks in (MSE+ISE+ESE) are needed and Min. 40% marks in ESE are needed. (ESE shall be a separate head of passing)

Walchand College of Engineering, Sangli

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AY 2024-25

Course Information	
Programme	M. Tech. (Thermal Engineering)
Class, Semester	First Year M. Tech., Sem II
Course Code	1TH523
Course Name	Internal Combustion Engine Design
Desired Requisites:	Thermodynamics, Heat Transfer

Teaching Scheme		**Examination Scheme (Marks)**			
Lecture	3 Hrs/week	**MSE**	**ISE**	**ESE**	**Total**
Tutorial	-	30	20	50	100
		Credits: 3			

Course Objectives	
1	To enable the students to analyze and solve I.C.Engine related problems by applyingprinciples of mathematics, science and engineering.
2	To prepare students to use modern tools, techniques and skills to fulfill industrial needsrelated I.C.Engine systems.
3	To train students with effective communication skill to demonstrate I.C.Engine theories.
4	To develop skills in the analysis of I.C.Engine systems in research or design.
5	To develop a professional approach to lifelong learning in the I.C.Engine to include theawareness of social and environment issues associated with engineering practices

Course Outcomes (CO) with Bloom's Taxonomy Level

At the end of the course, the students will be able to

CO	**Course Outcome Statement/s**	**Bloom's Taxonomy Level**	**Bloom's Taxonomy Description**
CO1	Explain the thermodynamic cycles used in internal combustion engines.	II	Understanding
CO2	Apply the knowledge of mathematics, science, and engineering for the needs in I.C. Engine.	III	Applying
CO3	Analyse the I C engine systems and its design report	IV	Analyzing
CO4	Evaluate performance of I.C. Engines under different conditions andinterpret the reports.	V	Evaluating

Module	**Module Contents**	**Hours**
I	**Introduction to Engine Design:** Engine selection, basic data for design like power torque, speed, mean effective pressure, air consumption, fuel consumption, stroke to bore ratio, heat distribution, exhaust temperature, power to weight ratio,	6
II	**Design Considerations:** Combustion chamber design considerations for S.I. and C.I. engines. Thermal and Mechanical design of cylinder, piston, piston rings, cylinder head, valves, Mechanical design of connecting rod, crankshaft and crank case.	6

III	**Simulation of I.C. Engine Processes** Simulation, S.I. Engine simulation with air as working medium,simulation with adiabatic combustion. Definitions of progressive combustion model, gas exchange process model and heat transferprocess model	7
IV	**Carburetion and Injection:** Carburetion Mixture characteristics ,distribution, Carburetor systems, Carburetor and stratified charge engines, S.I. Engine fuel injection system and type, Modern Carburetor designs and air Pollution control, altitude compensation. **Injection Systems:** Design, Bosch distribution pump, Cummins- P-T injection system, Spray characteristics ,quantity of fuel per cycle, types of nozzles, injection timing, fuel line hydraulics,	7
V	**Cooling System:** Design, Heat transfer in I.C. engines, piston and cylinder temperatures, heat rejected to coolant, comparison of air and water cooling, temperature distribution for air and water cooled engine across the cylinder wall, **Ignition System:** Requirements, battery ignition, magneto ignition and electronic ignition systems, centrifugal and vacuum advance; spark plug types and selection, firing order and its importance.	7
VI	**Other Engine Designs** **Wankel Engine:** Working principle, engine geometry, engine scaling, lubrication, cooling, induction, ignition systems, combustion in rotary engine, performance, advantages and applications	7

Text Books

1	J. B. Heywood I. C Engine Fundamentals”, Tata McGraw Hill Pub.1st edition 1998.
2	V. Ganesan, ‘Internal Combustion Engines’, Tata McGraw Hill Book Co, EighthReprint, 2005.

References

1	F. Obert, “Internal Combustion Engines and Air Pollution”, In-text EducationalPublishers, 1st edition 1973.
2	Colin Fergusson, Allan Kirkpatrick, “Internal Combustion Engines” Wiley Publication.
3	P. M. Heldt, “High Speed Combustion Engines”, Chilton company 4th edition 1956.

Useful Links

1	https://nptel.ac.in/courses/107/106/107106088/

CO-PO Mapping

	Programme Outcomes (PO)					
	1	**2**	**3**	**4**	**5**	**6**
CO1	1	2				
CO2					2	
CO3		2		3		
CO4	1		2			2

The strength of mapping is to be written as 1,2,3; Where, 1:Low, 2:Medium, 3:High
Each CO of the course must map to at least one PO.

Assessment

The assessment is based on MSE, ISE and ESE.
MSE shall be typically on modules 1 to 3.
ISE shall be taken throughout the semester in the form of teacher's assessment. Mode of assessment can be field visit, assignments etc. and is expected to map at least one higher order PO.
ESE shall be on all modules with around 40% weightage on modules 1 to 3 and 60% weightage on modules 4 to 6.
For passing a theory course, Min. 40% marks in (MSE+ISE+ESE) are needed and Min. 40% marks in ESE are needed. (ESE shall be a separate head of passing)

Walchand College of Engineering, Sangli

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AY 2024-25

Course Information	
Programme	M. Tech. (Thermal Engineering)
Class, Semester	First Year M. Tech., Sem II
Course Code	1TH571
Course Name	Steam Engineering Lab
Desired Requisites:	Thermodynamics

Teaching Scheme		**Examination Scheme (Marks)**			
Practical	2Hrs/Week	**LA1**	**LA2**	**LA ESE**	**Total**
Interaction	-	30	30	40	100
		Credits: 1			

Course Objectives	
1	To provide hands-on experience with advanced experimental techniques used steam engineering research and applications.
2	To enhance knowledge of heat exchangers, condensers, and evaporators used in steam applications..
3	To study the operation and performance of steam turbines and their role in power generation.

Course Outcomes (CO) with Bloom's Taxonomy Level

At the end of the course, the students will be able to,

CO	**Course Outcome Statement/s**	**Bloom's Taxonomy Level**	**Bloom's Taxonomy Description**
CO1	Explain the operation and functions of different types of boilers and steam turbines.	II	Understanding
CO2	Use steam tables and Mollier charts to solve problems related to steam systems.	III	Applying
CO3	Analyze the performance of steam generation and distribution systems through experimental data.	IV	Analyzing
CO4	Evaluate the effectiveness and efficiency of various steam system components and configurations.	V	Evaluating

List of Experiments / Lab Activities

List of Experiments:

Course Contents:

1. Steam Generators
2. Mounting and accessories
3. Quality of Steam
4. Energy Analysis of Steam Power Plant
5. Condenser Analysis
6. Cooling Tower

Text Books	
1	T. D. Estop, A. McConkey, Applied Thermodynamics, Parson Publication.
2	Domkundwar; A Course in Power Plant Engineering; Dhanapat Rai and Sons.
References	
1	Energy Performance Assessment for Equipment & Utility Systems; Bureau of Energy Efficiency.
2	P. Chatopadhyay; Boiler Operation Engineering: Questions and Answes; Tata McGrawHill Education Pvt Ltd, N Delhi
Useful Links	
1	https://nptel.ac.in/courses/112/107/112107216/

CO-PO Mapping						
	Programme Outcomes (PO)					
	1	**2**	**3**	**4**	**5**	**6**
CO1	3			1		
CO2			3			
CO3						
CO4					3	1
The strength of mapping is to be written as 1,2,3; Where, 1:Low, 2:Medium, 3:High Each CO of the course must map to at least one PO.						

Assessment				
There are three components of lab assessment, LA1, LA2 and Lab ESE. IMP: Lab ESE is a separate head of passing.(min 40 %), LA1+LA2 should be min 40%				
Assessment	**Based on**	**Conducted by**	**Typical Schedule (for 26-week Sem)**	**Marks**
LA1	Lab activities, attendance, journal	Lab Course Faculty	During Week 1 to Week 8 Marks Submission at the end of Week 8	30
LA2	Lab activities, attendance, journal	Lab Course Faculty	During Week 9 to Week 16 Marks Submission at the end of Week 16	30
Lab ESE	Lab activities, journal/ performance	Lab Course Faculty and External Examiner as applicable	During Week 18 to Week 19 Marks Submission at the end of Week 19	40
Week 1 indicates starting week of a semester. Lab activities/Lab performance shall include performing experiments, mini-project, presentations, drawings, programming, and other suitable activities, as per the nature and requirement of the lab course. The experimental lab shall have typically 8-10 experiments and related activities if any.				

Walchand College of Engineering, Sangli

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AY 2024-25

Course Information	
Programme	M. Tech. (Thermal Engineering)
Class, Semester	First Year M. Tech., Sem II
Course Code	1TH572
Course Name	CFD Lab
Desired Requisites:	Thermodynamics, Fluid Dynamics, Heat Transfer

Teaching Scheme		**Examination Scheme (Marks)**			
Practical	2Hrs/Week	**LA1**	**LA2**	**LA ESE**	**Total**
Interaction	-	30	30	40	100
		Credits: 1			

Course Objectives	
1	To Provide an overview of Computational Fluid Dynamics (CFD) principles, applications, and software.
2	To Learn to navigate user interfaces, set boundary conditions, and define simulation parameters.
3	To Understand the governing equations (Navier-Stokes, continuity, and energy equations) used in CFD simulations.

Course Outcomes (CO) with Bloom's Taxonomy Level

At the end of the course, the students will be able to,

CO	**Course Outcome Statement/s**	**Bloom's Taxonomy Level**	**Bloom's Taxonomy Description**
CO1	Describe the role and importance of turbulence modeling in simulating turbulent flows using various turbulence models.	II	Understanding
CO2	Apply CFD software tools proficiently to set up and solve basic fluid flow problems	III	Applying
CO3	Analyze CFD simulation results to interpret flow characteristics, such as velocity profiles, pressure distribution, and turbulence intensity..	IV	Analyzing
CO4	Assess the limitations and assumptions associated with CFD simulations in modeling complex flow phenomena.	V	Evaluating

List of Experiments / Lab Activities

List of Experiments:

Course Contents:

1. Flow Through a Pipe
2. Heat Transfer in a Heat Exchanger:
3. Flow Over an Airfoil
4. Mixing and Stirring in a Stirred Tank Reactor

Text Books

1	S.V. Patankar, “Numerical Fluid Flow & Heat transfer”, Hemisphere Publishing Corp., 1980.
2	T. Sundernajan, K. Muralidhar, “Computational Fluid Flow and Heat Transfer”, Narosa, 2ndedition, Reprint 2011
References	
1	H. K. Versteeg and W. Malalasekera, “An Introduction to Computational Fluid Dynamics”,Longman Scientific and Technical, 1st edition, 1995.
2	Hoffman Klaus, “Computational Fluid Dynamics”, Vol-1 & 2, A Publication of EngineeringEducation System, Wichita Kansas, USA, 2000
Useful Links	
1	https://nptel.ac.in/courses/112/104/112104302/

CO-PO Mapping						
	Programme Outcomes (PO)					
	1	**2**	**3**	**4**	**5**	**6**
CO1	3			1		
CO2			3			
CO3						
CO4					3	1

The strength of mapping is to be written as 1,2,3; Where, 1:Low, 2:Medium, 3:High
Each CO of the course must map to at least one PO.

Assessment

There are three components of lab assessment, LA1, LA2 and Lab ESE.
IMP: Lab ESE is a separate head of passing.(min 40 %), LA1+LA2 should be min 40%

Assessment	Based on	Conducted by	Typical Schedule (for 26-week Sem)	Marks
LA1	Lab activities, attendance, journal	Lab Course Faculty	During Week 1 to Week 8 Marks Submission at the end of Week 8	30
LA2	Lab activities, attendance, journal	Lab Course Faculty	During Week 9 to Week 16 Marks Submission at the end of Week 16	30
Lab ESE	Lab activities, journal/ performance	Lab Course Faculty and External Examiner as applicable	During Week 18 to Week 19 Marks Submission at the end of Week 19	40

Week 1 indicates starting week of a semester. Lab activities/Lab performance shall include performing experiments, mini-project, presentations, drawings, programming, and other suitable activities, as per the nature and requirement of the lab course. The experimental lab shall have typically 8-10 experiments and related activities if any.

Walchand College of Engineering, Sangli

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AY 2024-25

Course Information	
Programme	M. Tech. (Thermal Engineering)
Class, Semester	First Year M. Tech., Sem II
Course Code	1TH545
Course Name	Seminar
Desired Requisites:	

Teaching Scheme		**Examination Scheme (Marks)**			
Practical	2Hrs/Week	**LA1**	**LA2**	**LA ESE**	**Total**
Interaction	-	30	30	40	100
		Credits: 1			

Course Objectives	
1	To review and increase student's understanding of the specific topics..
2	To induce Learning management of values.
3	To teach how research papers are written and read such papers critically and efficiently and to summarize and review them to gain an understanding of a new field, in the absence of a textbook.

Course Outcomes (CO) with Bloom's Taxonomy Level

At the end of the course, the students will be able to,

CO	**Course Outcome Statement/s**	**Bloom's Taxonomy Level**	**Bloom's Taxonomy Description**
CO1	Identify and utilize credible sources of information, including academic journals, books, and databases..	II	Understanding
CO2	Apply the existing knowledge on real life problems	III	Applying
CO3	Investigate the selected topic/ system	IV	Analyzing
CO4	Verify the outcomes of the work have solved the specified problems..	V	Evaluating

List of Experiments / Lab Activities

Course Contents:

The seminar work should preferably be a problem with research potential, involve scientific research review, design, generation, collection, and analysis of data, determine a solution, and preferably bring out the individual contribution. The seminar should be based, preferably, on the area in which the candidate is interested to undertaking the dissertation work. The candidate has to be in regular contact with their guide, and the topic of the seminar must be mutually decided. The examination shall consist of the preparation of a report consisting of a literature review, a detailed problem statement, case studies, etc., according to the type of work carried out. The work has to be presented in front of the examiner panel formed by department for evaluation.

Text Books	
1	Suitable books based on the contents of the seminar topic selected.

References	
1	Suitable books based on the contents of the seminar topic selected and research papers from reputed national and international journals and conferences.
Useful Links	
1	As per the need of the seminar topic.

CO-PO Mapping						
	Programme Outcomes (PO)					
	1	**2**	**3**	**4**	**5**	**6**
CO1	2	3	1			
CO2	3					
CO3		3			1	
CO4					2	
The strength of mapping is to be written as 1,2,3; Where, 1:Low, 2:Medium, 3:High Each CO of the course must map to at least one PO.						

Assessment				
There are three components of lab assessment, LA1, LA2 and Lab ESE. IMP: Lab ESE is a separate head of passing.(min 40 %), LA1+LA2 should be min 40%				
Assessment	**Based on**	**Conducted by**	**Typical Schedule (for 26-week Sem)**	**Marks**
LA1	Lab activities, attendance, journal	Lab Course Faculty	During Week 1 to Week 8 Marks Submission at the end of Week 8	30
LA2	Lab activities, attendance, journal	Lab Course Faculty	During Week 9 to Week 16 Marks Submission at the end of Week 16	30
Lab ESE	Lab activities, journal/ performance	Lab Course Faculty and External Examiner as applicable	During Week 18 to Week 19 Marks Submission at the end of Week 19	40
Week 1 indicates starting week of a semester. Lab activities/Lab performance shall include performing experiments, mini-project, presentations, drawings, programming, and other suitable activities, as per the nature and requirement of the lab course. The experimental lab shall have typically 8-10 experiments and related activities if any.				

Walchand College of Engineering, Sangli *(Government Aided Autonomous Institute)*					
AY 2024-25					
Course Information					
Programme		M. Tech. (Thermal Engineering)			
Class, Semester		First Year M. Tech., Sem II			
Course Code		1TH531			
Course Name		Design of Heat Exchangers			
Desired Requisites:		Fundamentals of heat transfer and fluid mechanics			
Teaching Scheme		**Examination Scheme (Marks)**			
Lecture	3 Hrs/week	**MSE**	**ISE**	**ESE**	**Total**
Tutorial	-	30	20	50	100
		Credits: 3			

Course Objectives	
1	Enable the students to analyze and solve heat exchanger problems by applying principlesof mathematics, science and engineering.
2	Prepare students to use modern tools, techniques and skills to fulfill industrial needsrelated to design of heat exchanger.
3	Develop skills in the analysis of heat exchanger with mathematical modeling forapplications in research or design.

Course Outcomes (CO) with Bloom's Taxonomy Level

At the end of the course, the students will be able to

CO	**Course Outcome Statement/s**	**Bloom's Taxonomy Level**	**Bloom's Taxonomy Description**
CO1	Explain the fundamental principles and types of heat exchangers.	II	Understanding
CO2	Apply fundamental knowledge of mathematics, science, and engineering for the needs in heat exchanger designing.	III	Applying
CO3	Analyze the thermal and Hydraulic design of different types of heat exchangers	IV	Analyzing
CO4	Evaluate Heat Exchanger design	V	Evaluating

Module	**Module Contents**	**Hours**
I	**Types of heat exchanger** Heat Exchangers – Classification according to transfer process, number of fluids, surface compactness, and construction features. Tubular heat exchanger, plate type heat exchangers, extended surface heat exchangers, heat pipe, Regenerators. Classification according to flow arrangement: counter flow, parallel flow, cross flow exchanger.	6
II	**Heat exchanger design methodology** Assumption for heat transfer analysis, problem formulation, e-NTU method, *P*-NTU method, Mean temperature difference method, fouling of heat exchanger, effects of fouling, categories of fouling, fundamentalprocesses of fouling.	7
III	**Compact and Double Pipe Heat Exchangers** Thermal and Hydraulic design of compact heat exchanger. Thermal and Hydraulic design of inner tube, Thermal and hydraulic analysis of Annulus, Total pressure drop.	6

IV	**Direct-contact heat exchanger, cooling towers** Relation between the wet-bulb and dew point temperatures. The Lewis number, Classification of cooling towers cooling, tower internals and the role of fill, Heat exchange heat transfer by simultaneous diffusion and convection. Analysis of cooling towers measurements. Design of cooling towers, determination of the number of diffusion units.	7
V	**Shell and Tube heat exchangers** Tinker's, kern's, and Bell Delaware's methods, for thermal and hydraulic design of Shell and Tube heat exchangers	7
VI	**Mechanical Design of Heat Exchangers** Design standards and codes, key terms in heat exchanger design, material selection, and thickness calculation for major components such as tube sheet, shell, tubes, flanges and nozzles.	7

Text Books	
1	Ramesh K. Shah and Dusan P. Sekulic, "Fundamentals of Heat Exchanger Design"John Wiley and sons Inc., 2003.

References	
1	D.C. Kern, "Process Heat Transfer", McGraw Hill, 1950.
2	SadikKakac and Hongton Liu, "Heat Exchangers: Selection, Rating and ThermalDesign" CRC Press, 1998.
3	A .P. Frass and M.N. Ozisik, "Heat Exchanger Design", McGraw Hill, 1984
4	Afgan N. and Schlinder E.V. "Heat Exchanger Design and Theory Source Book".
5	T. Kuppan, "Hand Book of Heat Exchanger Design".
6	"T.E.M.A. Standard", New York, 1999.
7	G. Walkers, "Industrial Heat Exchangers-A Basic Guide", McGraw Hill, 1982.

Useful Links	
1	https://nptel.ac.in/courses/112/105/112105248/

CO-PO Mapping

	Programme Outcomes (PO)					
	1	**2**	**3**	**4**	**5**	**6**
CO1	1	2				
CO2	3					
CO3	3	2				2
CO4	3		2	2		

The strength of mapping is to be written as 1,2,3; Where, 1:Low, 2:Medium, 3:High

Assessment

The assessment is based on MSE, ISE and ESE.
MSE shall be typically on modules 1 to 3.
ISE shall be taken throughout the semester in the form of teacher's assessment. Mode of assessment can be field visit, assignments etc. and is expected to map at least one higher order PO.
ESE shall be on all modules with around 40% weightage on modules 1 to 3 and 60% weightage on modules 4 to 6.
For passing a theory course, Min. 40% marks in (MSE+ISE+ESE) are needed and Min. 40% marks in ESE are needed. (ESE shall be a separate head of passing)

Walchand College of Engineering, Sangli *(Government Aided Autonomous Institute)*					
AY 2024-25					
Course Information					
Programme		M. Tech. (Thermal Engineering)			
Class, Semester		First Year M. Tech., Sem II			
Course Code		1TH532			
Course Name		Industrial Refrigeration			
Desired Requisites:		Thermodynamics, Heat Transfer			
Teaching Scheme		**Examination Scheme (Marks)**			
Lecture	3 Hrs/week	**MSE**	**ISE**	**ESE**	**Total**
Tutorial	-	30	20	50	100
		Credits: 3			

Course Objectives	
1	To enable the students to analyse and solve refrigeration related problems by applyingprinciples of mathematics, science and engineering.
2	To prepare students to use modern tools, techniques and skills to fulfill industrial needsrelated to refrigeration systems.
3	To train students with effective communication skill to demonstrate refrigeration/theories.
4	To develop skills in the analysis of refrigeration systems in research or design.

Course Outcomes (CO) with Bloom's Taxonomy Level

At the end of the course, the students will be able to

CO	Course Outcome Statement/s	Bloom's Taxonomy Level	Bloom's Taxonomy Description
CO1	Describe the basic types and components of industrial refrigeration systems.	II	Understanding
CO2	Apply knowledge of mathematics, science, and engineering for the needs in Refrigeration	III	Applying
CO3	Analyse different Refrigeration systems and their characteristics	IV	Analyzing
CO4	Evaluate the performance of different refrigeration systems	V	Evaluating

Module	Module Contents	Hours
I	Industrial refrigeration as distinguished from comfort air-conditioning, What is industrial refrigeration, Refrigerated storage of unfrozen food, Frozen food, Refrigeration in food processing, freeze drying	6
II	Carnot cycle , conditions for high cop of Carnot cycle ,Steady flowenergy equation, Analysis of Carnot cycle using refrigerant enthalpies, Dry vs wet compression, The standard vapour compression cycle	7
III	Reciprocating, scroll and screw compressor: Multistage industrialapplications, cylinder arrangement, cooling methods - oil injection	7

IV	Types of Evaporators, Liquid circulation: Mechanical pumping and gas pumping - advantage and disadvantage of liquid re-circulation - circulation ratio - top feed and bottom feed refrigerant - Net Positive Suction Head (NPSH) - two pumping vessel system – suction risers, design, piping loses. Different Industrial Condensers arrangement	7
V	Vessels in industrial refrigeration: High pressure receiver - flash tank -liquid and vapor separator, separation enhancers, low pressure receivers, surge drum	6
VI	Conservation and design considerations - source of losses - critical thickness – insulation cost and energy cost - vapor barriers – construction methods of refrigerated spaces.	7
Text Books		
1	C. P. Arora ,"Refrigeration and Air conditioning", Tata Mcgraw Hill EducationPrivate Limited , third edition,2008.	
2	Wilbert F. Stoecker, Industrial refrigeration handbook, Mcgraw-hill ProfessionalPublishing 1st edition., ,1998	
References		
1	Roy J. Dossat "Principals of Refrigeration", Pearson, 4th edition, 2007	
2	ASHRAE1998. Hand Book: Refrigeration,	
3	ASHRAE Hand Book: HVAC Systems and Equipment, 1996. Journal of Airconditioning and refrigeration- ISHRAE, ASHRAE.	
Useful Links		
1	https://nptel.ac.in/courses/112/105/112105129/	

CO-PO Mapping						
	Programme Outcomes (PO)					
	1	**2**	**3**	**4**	**5**	**6**
CO1	1	2				
CO2	1			1		
CO3	2		2	2		
CO4			1	2		
The strength of mapping is to be written as 1,2,3; Where, 1:Low, 2:Medium, 3:High Each CO of the course must map to at least one PO.						

Assessment
The assessment is based on MSE, ISE and ESE. MSE shall be typically on modules 1 to 3. ISE shall be taken throughout the semester in the form of teacher's assessment. Mode of assessment can be field visit, assignments etc. and is expected to map at least one higher order PO. ESE shall be on all modules with around 40% weightage on modules 1 to 3 and 60% weightage on modules 4 to 6. For passing a theory course, Min. 40% marks in (MSE+ISE+ESE) are needed and Min. 40% marks in ESE are needed. (ESE shall be a separate head of passing)

Walchand College of Engineering, Sangli

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AY 2024-25

Course Information

Programme	M. Tech. (Thermal Engineering)
Class, Semester	First Year M. Tech., Sem II
Course Code	1TH533
Course Name	Food Preservation and Cold Chain Management
Desired Requisites:	Refrigeration and air conditioning

Teaching Scheme		**Examination Scheme (Marks)**			
Lecture	3 Hrs/week	**MSE**	**ISE**	**ESE**	**Total**
Tutorial	0 Hrs/week	30	20	50	100
		Credits: 3			

Course Objectives

1	To understand the importance microorganisms in food preservation
2	To introduce the basics of various food processing and preservation technologies
3	To know the need and importance of preservation in dairy and fishery industry.
4	To analyze the compositional and technological aspects of milk and fish and other food products
5	To apply study of food preservation for preservation of various food products.

Course Outcomes (CO) with Bloom's Taxonomy Level

At the end of the course, the students will be able to,

CO	**Course Outcome Statement/s**	**Bloom's Taxonomy Level**	**Bloom's Taxonomy Description**
CO1	Describe the importance of microorganisms in food preservation. To introduce the basics of various food processing and preservation technologies	II	Understanding
CO2	Identify food preservation for preservation of various food products and cold chain management	III	Applying
CO3	Analyse the compositional and technological aspects of milk and fish and other food products during preservation	IV	Analysing
CO4	Evaluate the effectiveness and efficiency of food preservation and cold chain management strategies.	V	Evaluating

Module	**Module Contents**	**Hours**
I	Food Microbiology: Principles of Food Preservation, microorganisms associated with foods bacteria, yeast and mold, Importance of bacteria, yeast and molds in foods. Classification of microorganisms based on temperature, pH, water activity, nutrient and oxygen requirements, typical growth curve of microorganisms. Classification of food based on pH, Food infection, food intoxication, definition of shelf life, perishable foods, semi perishable foods, shelve stable foods.	7
II	Food Preservation by Low temperature Freezing and Refrigeration: Introduction to refrigeration, cool storage and freezing, definition, principle of freezing, freezing curve, changes occurring during freezing, types of freezing i.e. slow freezing, quick freezing, introduction to thawing, changes during thawing and its effect on food. Freezing methods -direct and indirect, still air sharp freezer, blast freezer, fluidized freezer, plate freezer, spiral freezer and cryogenic freezing.	7
III	Food Preservation by high temperature: Commercial heat preservation methods: Sterilization, commercial sterilization, Pasteurization, and blanching.	6

IV	Food Preservation by Moisture control: Drying and Dehydration - Definition, drying as a means of preservation, differences between sun drying and dehydration (i.e. mechanical drying), heat and mass transfer, factors affecting rate of drying, normal drying curve, names of types of driers used in the food industry. Drying methods and equipment, air convection dryer, tray dryer, tunnel dryer, continuous belt dryer, fluidized bed dryer, spray dryer, drum dryer, vacuum dryer, freeze drying ,foam mat drying. Evaporation-Definition, factors affecting evaporation, names of evaporators used in food industry.	7
V	Food Preservation by Irradiation and chemicals Introduction, units of radiation, kinds of ionizing radiations used in food irradiation, mechanism of action, uses of radiation processing in food industry, concept of cold sterilization. Recent Trends Pulsed electric fields, High pressure technology, Ohmic heating, Microwave heating, Hurdle technology.	6
VI	Cold chain and Cold Chain Management Freezing: requirements of refrigerated storage - controlled low temperature, air circulation and humidity, changes in food during refrigerated storage, progressive freezing, changes during freezing – concentration effect and ice crystal damage, freezer burn. Maintenance of controlled environment during transportation and sales outlets.	7

Textbooks	
1	Potter NH, Food Science, CBS Publication, New Delhi, 1998.
2	Ramaswamy H and Marcott M, Food Processing Principles and Applications CRC Press,2006

References	
1	B. Srilakshmi, Food science, New Age Publishers,2002
2	Meyer, Food Chemistry, New Age,2004
3	Bawa. A.S, O.P Chauhanetal. Food Science. New India Publishing agency, 2013
4	Frazier WC and Westhoff DC, Food Microbiology, TMH Publication, New Delhi, 2004
5	Desrosier NW and Desrosier JN, The Technology of Food Preservation, CBS Publication, New Delhi, 1998
6	Paine FA and Paine HY, Handbook of Food Packaging, Thomson Press India Pvt Ltd, New Delhi- 1992
7	Toledo Romeo T, Fundamentals of Food Process Engineering, Aspen Publishers, 1999

Useful Links	
1	https://nptel.ac.in/courses/126/105/126105011/
2	https://nptel.ac.in/courses/126/103/126103017/

CO-PO Mapping

	Programme Outcomes (PO)					
	1	**2**	**3**	**4**	**5**	**6**
CO1				2	3	
CO2				2	2	
CO3			2			
CO4					2	

The strength of mapping is to be written as 1,2,3; Where, 1:Low, 2:Medium, 3:High
Each CO of the course must map to at least one PO.

Assessment

The assessment is based on MSE, ISE and ESE.
MSE shall be typically on modules 1 to 3.
ISE shall be taken throughout the semester in the form of teacher’s assessment. Mode of assessment can be field visit, assignments etc. and is expected to map at least one higher order PO.
ESE shall be on all modules with around 40% weightage on modules 1 to 3 and 60% weightage on modules 4 to 6.
For passing a theory course, Min. 40% marks in (MSE+ISE+ESE) are needed and Min. 40% marks in ESE are needed. (ESE shall be a separate head of passing)

Walchand College of Engineering, Sangli

(Government Aided Autonomous Institute)

AY 2024-25

Course Information	
Programme	M. Tech. (Thermal Engineering)
Class, Semester	First Year M. Tech., Sem II
Course Code	1TH534
Course Name	Cryogenics
Desired Requisites:	Refrigeration and air conditioning

Teaching Scheme		Examination Scheme (Marks)			
Lecture	3 Hrs/week	**MSE**	**ISE**	**ESE**	**Total**
Tutorial	0 Hrs/week	30	20	50	100
		Credits: 3			

Course Objectives	
1	To Understand the basic principles of cryogenics and low-temperature physics.
2	To Analyze the properties and behaviors of materials at cryogenic temperatures.
3	To Design and evaluate cryogenic systems and equipment.
4	To Apply cryogenic techniques in practical scenarios across different industries.

Course Outcomes (CO) with Bloom's Taxonomy Level

At the end of the course, the students will be able to,

CO	Course Outcome Statement/s	Bloom's Taxonomy Level	Bloom's Taxonomy Description
CO1	Explain the basic principles of low-temperature physics and their significance.	II	Understanding
CO2	Apply knowledge of cryogenic materials to select appropriate materials for specific applications.	III	Applying
CO3	Examine the safety protocols and risk assessments necessary for handling cryogenic systems.	IV	Analysing
CO4	Assess the design and functionality of cryogenic storage and transfer systems.	V	Evaluating

Module	Module Contents	Hours
I	**Introduction to Cryogenics** VCRS Cycle, Limitation of VCRS System, Cascade system, History and development of cryogenics. Basic principles of thermodynamics relevant to cryogenics.	7
II	**Gas Liquefaction, Separation and Purification System** Thermodynamically ideal system, Joule-Thomson effect, Adiabatic expansion, Actual liquefaction systems, Performance parameters, Critical components of liquefaction systems. Ideal gas separation system, separation of binary mixtures at cryogenic temperatures, Requirement of Purification, Purification systems at low temperatures.	7
III	**Cryogenic Refrigeration Systems** Joule-Thompson Refrigeration systems, Expansion engine refrigeration systems, Philips refrigerators, G-M Refrigerators, Stirling Refrigerator, Solvay Refrigerator, Magnetic Refrigeration.	6
IV	**Properties of Engineering Materials** Material properties at low temperatures, Thermal, Mechanical and Magnetic properties of cryogens..	7
V	**Cryogenic Fluid Storage, Handling and Transfer** Handling, Insulation, Instrumentation & Vacuum Technology Temperature, Pressure, Flow rate and Liquid level measurement. Cryogenic storage vessels, Dewar and large tanks, Storage and transport of LNG and other liquefied industrial gases. Liquid hydrogen storage and transport for hydrogen-fueled vehicle. Special insulation requirements at low temperatures, insulating materials. Need of vacuum, various vacuum pumps.	6

VI	**Safety, Applications, and Recent Advances** Safety protocols and risk assessment in cryogenics, Applications: MRI, cryosurgery, superconducting magnets, particle accelerators, Recent advancements and research in cryogenics. Future trends and potential innovations in the field.	7

Textbooks	
1	Cryogenics, Dr. B. S. Gawali, Mahalaxmi Publication..
2	"Cryogenic Engineering" by R. B. Scott
References	
1	Helium Cryogenics" by Steven W. Van Sciver
2	"Handbook of Cryogenic Engineering" edited by J.G. Weisend II
3	Fundamentals of Cryogenic Engineering" by Mamoru Ishigaki and Nobuyuki Yoshida
Useful Links	
1	https://archive.nptel.ac.in/courses/112/101/112101004/

CO-PO Mapping

	Programme Outcomes (PO)					
	1	**2**	**3**	**4**	**5**	**6**
CO1				2	3	
CO2				2	2	
CO3			2			
CO4					2	

The strength of mapping is to be written as 1,2,3; Where, 1:Low, 2:Medium, 3:High
Each CO of the course must map to at least one PO.

Assessment

The assessment is based on MSE, ISE and ESE.
MSE shall be typically on modules 1 to 3.
ISE shall be taken throughout the semester in the form of teacher's assessment. Mode of assessment can be field visit, assignments etc. and is expected to map at least one higher order PO.
ESE shall be on all modules with around 40% weightage on modules 1 to 3 and 60% weightage on modules 4 to 6.
For passing a theory course, Min. 40% marks in (MSE+ISE+ESE) are needed and Min. 40% marks in ESE are needed. (ESE shall be a separate head of passing)

Walchand College of Engineering, Sangli

(Government Aided Autonomous Institute)

AY 2024-25

Course Information

Programme	M. Tech. (Thermal Engineering)
Class, Semester	First Year M. Tech., Sem II
Course Code	1TH535
Course Name	Industrial Air-Conditioning
Desired Requisites:	Refrigeration and air conditioning

Teaching Scheme		**Examination Scheme (Marks)**			
Lecture	3 Hrs/week	**MSE**	**ISE**	**ESE**	**Total**
Tutorial	0 Hrs/week	30	20	50	100
		Credits: 3			

Course Objectives

1	To enable the students to analyze and solve air conditioning related problems by applying principles of mathematics, science and engineering..
2	To prepare students to use modern tools, techniques and skills to fulfil industrial needsrelated to air conditioning.
3	To train students with effective communication skills to demonstrate air conditioningtheories.
4	To develop skills in the analysis of air conditioning systems in research or design.

Course Outcomes (CO) with Bloom's Taxonomy Level

At the end of the course, the students will be able to,

CO	**Course Outcome Statement/s**	**Bloom's Taxonomy Level**	**Bloom's Taxonomy Description**
CO1	Explain the principles, processes, equipment's of psychometric and air conditioning	II	Understanding
CO2	Apply knowledge of mathematics, science and engineering for the needs in air-conditioning.	III	Applying
CO3	Analyze different Air-Conditioning systems and their characteristics.	IV	Analysing
CO4	Evaluate the performance and interpret the report in the field of Air Conditioning.	V	Evaluating

Module	**Module Contents**	**Hours**
I	Psychrometry: moist air properties; mass transfer and evaporation of water into moist air; theory of psychrometer; correlation of w.b.t. with temperature of adiabatic saturation; Lewis number; construction of psychrometric chart.	7
II	Heat and Mass Transfer: Direct contact transfer equipment; simple air washer and indirect evaporative cooling contact mixture principle; enthalpy potential; basic equation for direct contact transfer equipment; graphical and analytical methods for heat and mass transfer analysis of air washers with heated and chilled water sprays	7
III	Ventilation: Necessity; ventilation standards; natural and mechanical ventilation; forces for natural ventilation; general ventilation rules; determining ventilation requirement; use of decay equation.	6
IV	Air Cleaning: Physical and chemical vitiation of air; permissible concentration of air contaminants; mechanical and electronic air cleaners; dry and wet filters; radiators and convectors. Design of a year-round air conditioning system.	7
V	Air handling Equipment: Fans & Duct System Characteristics, Fan Arrangement Variable Air Volume systems, Air Handling Units and Fan Coil units. air conditioning apparatus, unitary equipment, accessory equipment, Noise control. Piping and Ducts: Pressure drops in piping and fittings; design of water and refrigerant piping; Air conditioning duct design methods.	6
VI	Industrial Applications: Major uses of air conditioning for medium sized & large industrial buildings. Application of air conditioning in Pharmaceutical, textile industry.	7

Textbooks

1	Manohar Prasad, “Refrigeration & Air Conditioning”, New Age Publishers.
2	Stoecker, “Refrigeration & Air Conditioning”, McGraw Hill, 1992.

References

1	ASHRAE Handbook.: HVAC Systems and Equipment, 1996.
2	Hainer R.W., “Control Systems for Heating, Ventilation and Air-Conditioning”, Van Nostrand
3	Norman C. Harris, “Modern Air Conditioning”, New York, McGraw-Hill,1974.

Useful Links

1	https://www.youtube.com/watch?v=3oupVAmC5mE

CO-PO Mapping

	Programme Outcomes (PO)					
	1	**2**	**3**	**4**	**5**	**6**
CO1				2	3	
CO2				2	2	
CO3			2			
CO4					2	

The strength of mapping is to be written as 1,2,3; Where, 1:Low, 2:Medium, 3:High
Each CO of the course must map to at least one PO.

Assessment

The assessment is based on MSE, ISE and ESE.
MSE shall be typically on modules 1 to 3.
ISE shall be taken throughout the semester in the form of teacher’s assessment. Mode of assessment can be field visit, assignments etc. and is expected to map at least one higher order PO.
ESE shall be on all modules with around 40% weightage on modules 1 to 3 and 60% weightage on modules 4 to 6.
For passing a theory course, Min. 40% marks in (MSE+ISE+ESE) are needed and Min. 40% marks in ESE are needed. (ESE shall be a separate head of passing)

Walchand College of Engineering, Sangli

(Government Aided Autonomous Institute)

AY 2024-25

Course Information	
Programme	M. Tech. (Thermal Engineering)
Class, Semester	First Year M. Tech., Sem II
Course Code	1TH536
Course Name	Energy Conservation and Management
Desired Requisites:	Environment Studies, Elements of Mechanical Engineering, Thermodynamics

Teaching Scheme		**Examination Scheme (Marks)**			
Lecture	3 Hrs/week	**MSE**	**ISE**	**ESE**	**Total**
Tutorial	0 Hrs/week	30	20	50	100
		Credits: 3			

Course Objectives	
1	To emphasis the student to study and understand the energy data of industries.
2	To explain the problems energy accounting and balancing
3	To workout energy audit and motivate the students to suggest methodologies for energy savings..
4	To prepare the students utilize the available resources in optimal ways
5	To emphasis the student to study and understand the energy data of industries.

Course Outcomes (CO) with Bloom's Taxonomy Level

At the end of the course, the students will be able to,

CO	Course Outcome Statement/s	Bloom's Taxonomy Level	Bloom's Taxonomy Description
CO1	Describe various energy conservation techniques and their applications in different sectors.	II	Understanding
CO2	Use energy audit tools and techniques to assess the energy performance of buildings and industrial processes.	III	Applying
CO3	Exercise energy audit and suggest methodologies for energy savings	IV	Analysing
CO4	Review and interpret energy policies and their implications for energy management practices.	V	Evaluating

Module	Module Contents	Hours
I	Commercial and non-commercial energy, Primary energy resources, Commercial energy production, Final energy consumption, Indian energy scenario, Sectorial energy consumption, Energy needs of growing economy, Energy intensity on purchasing power parity (PPP) basis, Long term energy scenario, Energy pricing, Energy security, Energy strategy for the future, Energy conservation and its importance	6
II	Energy auditing – methodology & analysis, Definition of energy management & its objectives, energy audit, need, types of energy audit, energy performance, matching energy use to requirements, maximizing systems efficiencies, energy audit instruments and metering.	7
III	Financial Management – Investment need, Appraisal and criteria Financial Analysis techniques, Simple Payback Period, Return On Investment, Net Present Value, Interest rate of return, Risk and sensitivity analysis, Financing Options, ESCOS.	7
IV	Energy Conservation in energy Intensive Industries. Cogeneration – Need, Principle, Technical Options for Cogeneration. Classification, Factors Influencing choice, Heat to Power ratios, Load Patterns, Prime movers used in Conservation. Advantages and Disadvantages of various systems. Case Studies	7
V	Energy and environment, Air pollution, Climate change, United Nations Framework Convection on Climate Change (UNFCCC), Kyoto Protocol, Conference of Parties (COP), Clean Development Mechanism (CDM), CDM methodology and procedure, Sustainable Development.	6
VI	Energy conservation in compressed air systems, HVAC & Refrigeration Systems, Fans, Blowers, Pumps & Pumping Systems, Cooling Towers, Lighting Systems	6

Textbooks	
1	Energy Manager Training Manual (4 Volumes) available at www.energymanager training.com, a website administered by Bureau of Energy Efficiency (BEE), a statutory body under Ministry of Power, Government of India, 2004
References	
1	Energy Management: W.R.Murphy, G.Mckay (Butterworths)
2	Witte. L.C., P.S. Schmidt, D.R. Brown, "Industrial Energy Management and Utilisation", Hemisphere Publ, Washington, 1988
3	Callaghn, P.W. "Design and Management for Energy Conservation", Pergamon Press, Oxford
Useful Links	
1	https://archive.nptel.ac.in/courses/112/105/112105221/

CO-PO Mapping						
	Programme Outcomes (PO)					
	1	**2**	**3**	**4**	**5**	**6**
CO1				2	3	
CO2				2	2	
CO3			2			
CO4					2	

The strength of mapping is to be written as 1,2,3; Where, 1:Low, 2:Medium, 3:High
Each CO of the course must map to at least one PO.

Assessment

The assessment is based on MSE, ISE and ESE.
MSE shall be typically on modules 1 to 3.
ISE shall be taken throughout the semester in the form of teacher's assessment. Mode of assessment can be field visit, assignments etc. and is expected to map at least one higher order PO.
ESE shall be on all modules with around 40% weightage on modules 1 to 3 and 60% weightage on modules 4 to 6.
For passing a theory course, Min. 40% marks in (MSE+ISE+ESE) are needed and Min. 40% marks in ESE are needed. (ESE shall be a separate head of passing)

Walchand College of Engineering, Sangli

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AY 2024-25

Course Information	
Programme	M. Tech. (Thermal Engineering)
Class, Semester	First Year M. Tech., Sem II
Course Code	7OE504
Course Name	Waste to Energy
Desired Requisites:	Environment Studies, Elements of Mechanical Engineering, Thermodynamics

Teaching Scheme		**Examination Scheme (Marks)**			
Lecture	3 Hrs/week	**MSE**	**ISE**	**ESE**	**Total**
Tutorial	0 Hrs/week	30	20	50	100
		Credits: 3			

Course Objectives	
1	To understand the grave problem of urban solid waste disposal and methods to tackle this problem.
2	To apply various energy conversion methods using biomass
3	To Study and analyze the biogas energy conversion process
4	To Study the Waste To Energy & Environmental Implications.

Course Outcomes (CO) with Bloom's Taxonomy Level

At the end of the course, the students will be able to,

CO	**Course Outcome Statement/s**	**Bloom's Taxonomy Level**	**Bloom's Taxonomy Description**
CO1	Describe various methods of conversion of waste to energy.	II	Understanding
CO2	Implement basic procedures for operating waste-to-energy conversion systems.	III	Applying
CO3	Compare different waste-to-energy processes to determine their suitability for specific types of waste.	IV	Analysing
CO4	Critically assess the sustainability and regulatory compliance of waste-to-energy systems.	V	Evaluating

Module	**Module Contents**	**Hours**
I	Introduction – Waste production in different sectors such as domestic, industrial, agriculture, post-consumer, waste etc. Classification of waste-agro based, forest residues, domestic waste, industrial waste (hazardous and non-hazardous), Characterization of waste for energy utilization, Characterization of wastes, Waste to energy by incineration process, Incineration plant furnaces & boilers.	7
II	Biomass Pyrolysis: Pyrolysis – Types, slow fast – Manufacture of charcoal – Methods - Yields and application. Manufacture of pyrolytic oils and gases, yields and applications	6
III	Biomass Gasification: Gasifiers- Fixed bed system- Downdraft and updraft gasifiers, Fluidized bed gasifiers- construction and operation – Gasifier burner arrangement for thermal heating. Gasifier engine arrangement and electrical power – Equilibrium and kinetic consideration in gasifier operation	7
IV	Biomass Combustion: Biomass stoves – Improved chullahs, types, some exotic designs, Fixed bed combustors, Types, inclined grate combustors, Fluidized bed combustors, construction and operation.	7
V	Biogas: Properties of biogas (Calorific value and composition) - Biogas plant technology and status - Bio energy system - Design and constructional features Biochemical conversion - anaerobic digestion - Types of biogas Plants Applications - Alcohol production from biomass - Bio diesel production.	6
VI	Waste To Energy & Environmental Implications- Environmental standards for waste to energy plant operations and gas clean-up. Savings on non-renewable fuel resources. Carbon Credits: Carbon foot calculations and carbon credits transfer mechanisms.	6

Textbooks

1	Energy Technology- S. Rao and B. B. Parulekar, Khanna Publication
2	S . P. Sukhatme, " Solar Energy", McGraw Hill Education, 3rd Edition,2015
References	
1	Annual Report 2006, Ministry of new and renewable energy, Government of India, New Delhi.
2	Energy Handbook, R. L. Loftness Van NOstrand Reinhold
3	H. Shah et al., Integrated renewable energy for rural development, 1990, Tata Mc Graw Hill.
Useful Links	
1	https://onlinecourses.nptel.ac.in/noc20_ch16/preview

CO-PO Mapping						
	Programme Outcomes (PO)					
	1	**2**	**3**	**4**	**5**	**6**
CO1				2	3	
CO2				2	2	
CO3			2			
CO4					2	

The strength of mapping is to be written as 1,2,3; Where, 1:Low, 2:Medium, 3:High
Each CO of the course must map to at least one PO.

Assessment

The assessment is based on MSE, ISE and ESE.
MSE shall be typically on modules 1 to 3.
ISE shall be taken throughout the semester in the form of teacher's assessment. Mode of assessment can be field visit, assignments etc. and is expected to map at least one higher order PO.
ESE shall be on all modules with around 40% weightage on modules 1 to 3 and 60% weightage on modules 4 to 6.
For passing a theory course, Min. 40% marks in (MSE+ISE+ESE) are needed and Min. 40% marks in ESE are needed. (ESE shall be a separate head of passing)