GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Bachelor of Engineering
Level: UG
Subject Code: BE04000311
Subject Name: Fluid Mechanics and Heat Transfer

w. e. f. Academic Year:	2024-25
Semester:	4
Category of the Course:	Professional Core Course

Prerequisite:	Nil
Rationale:	This course is intended to impart fundamental knowledge regarding fluid, its types, properties and basic governing equations in static and moving conditions. The course is also prepared to provide the detailed understating of various modes of heat transfer and its applications in Manufacturing Engineering.

Course Outcomes:

Sr. No.	CO statement	Marks% weightage
CO-1	To summarize various fluid properties.	14
CO-2	To summarize behavior of fluid in static and dynamic conditions.	28
CO-3	To classify the heat transfer problems and to apply the principles of steady state one dimensional heat transfer and extended surface.	22
CO-4	To identify the type of convection problems and to apply concepts of natural and forced convection for related problems.	18
CO-5	To explain various laws of radiation heat transfer and to determine the radiation heat transfer between black and grey surfaces of simple Mechanical systems.	18

Teaching and Examination Scheme:

Teaching / Learning Scheme (in Hours per semester)					Total Credits	Assessment Pattern and Marks					Total Marks
						Theory		Tutorial / Practical			
L	T	P	PBL	Total no of hours per semester		ESE (E)	PA / CA (M)	PA/CA (I)	PBL (I)	ESE (V)	
45	00	30	45	120	04	70	30	20	30	50	200

Content:

Sr. No.	Content	Total Hrs
1	**Fluids and Their Properties:** Fluid classifications, hypothesis of continuum, shear stress in a moving fluid, molecular structure of material, density, viscosity, surface tension, capillary effect, vapor pressure, compressibility and the bulk modulus, pressure, Pascal's law of pressure at a point, variation of pressure vertically in a fluid under gravity, equality of pressure at the same level in a static fluid, general equation for the variation of pressure due to gravity from a point to point in a static fluid, pressure and head, hydrostatic paradox	06
2	**Static Forces on Surface and Buoyancy:** Fluid static, action of fluid pressure on surface, resultant force and center of pressure on a plane surface under uniform pressure and surface immersed in a liquid, pressure diagrams, forces on a curved surface due to hydrostatic pressure, buoyancy, equilibrium of floating bodies, stability of a submerged body and floating bodies, determination of the metacentric height, determination of the position of the metacenter relative to the center of buoyancy	06
3	**Motion of Fluid Particles and Streams:** Different types of fluid flow, frames of reference, analyzing fluid flow, motion of a fluid particle, acceleration of a fluid particle, discharge and mean velocity, continuity of flow, continuity equations for 2-D flow in Cartesian coordinates of system **The Energy Equation and its Application:** Momentum and fluid flow, Momentum equation for 2-D flow along a stream line, momentum correction factor, Euler's equation of motion along a stream line, mechanical energy of a flowing fluid, Bernoulli's theorem, kinetic energy correction factor, principle of venturimeter, orifice, rotameter	07
4	**Conduction:** Fourier's law, effect of temperature on thermal conductivity of different solids, liquids and gases, generalized equation in Cartesian and cylindrical coordinates and its reduction to specific cases, One dimensional steady state conduction, heat conduction through plane and composite walls and cylinders, electrical analogy, critical radius of insulation for cylinder, overall heat transfer coefficient **Heat transfer from extended surface:** Types of fin, heat flow through uniform cross-sectional area fin insulated at the tip, efficiency and effectiveness of fin	10
5	**Convection:** Newton's law of cooling, dimensional analysis applied to forced and free convection, dimensionless numbers and their physical significance, empirical correlations for free and forced convection, Continuity, momentum and energy equations, thermal and hydrodynamic boundary layer	08
6	**Radiation:** Absorptivity, reflectivity and transmissivity, black, white and grey body, emissive power, emissivity, Kirchhoff's law, Planck's law, Rayleigh-Jeans' law, Wien's law, Wien's displacement law, Stefan-Boltzmann law, intensity of radiation, radiation heat exchange between black bodies, shape factor, radiation heat exchange between gray bodies, radiation shields	08
	TOTAL	**45**

Suggested Specification table with Marks (Theory):

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
20	**40**	**40**	**00**	**00**	**00**

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

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

Reference Books:

1. Fluid Mechanics and Fluid Power Engineering by D.S. Kumar, S. K. Kataria & Sons
2. Fluid Mechanics and Hydraulic Machines by R.K. Bansal, Laxmi Prakashan
3. Fluid Mechanics and Hydraulic Machines by R.K. Rajput, S.Chand & Co.
4. Heat and Mass Transfer by P.K. Nag, McGraw Hill
5. Heat and Mass Transfer: Fundamentals and Application by Yunus Cengel, McGraw Hill
6. Fundamental of Heat and Mass Transfer by Incropera and Dewitt, Wiley Publication

List of Experiments: (at least ten experiments from the following list should be performed)

1. To verify of Bernoulli's theorem.
2. To determine metacentric height by metacentric height apparatus.
3. To measure the velocity of flow using orifice meter and venturimeter.
4. To determine the thermal conductivity of given metal rod
5. To determine the thermal conductivity of the given composite walls.
6. To determine Stephan Boltzmann constant experimentally.
7. To determine heat transfer co-efficient by forced convection.
8. To determine heat transfer co-efficient by natural convection.
9. To determine the emissivity of gray body.
10. To measure convective heat transfer co-efficient and effectiveness of the fin under forced convection.
11. To measure convective heat transfer co-efficient and effectiveness of the fin under natural convection.
12. To determine critical radius of insulation.

Major Equipment: Bernoulli's theorem apparatus, Flow measuring devices and arrangements, metacentric height apparatus, Pin fin apparatus, Emissivity measurement apparatus, Composite wall apparatus, Stefan Boltzman apparatus, Natural and force convection apparatus, critical radius apparatus

List of Open-Source Software/learning website:

1. https://onlinecourses.nptel.ac.in/noc25_ce107/preview
2. https://onlinecourses.nptel.ac.in/noc25_me171/preview
3. https://onlinecourses.nptel.ac.in/noc25_ch87/preview

List of suggested activities for Problem Based Learning:

Sr. No.	Name of the activity	No. of hours	Evaluation Criteria
1.	Industry/Research laboratory visit	Visit = 5hrs., Report preparation = 5h Total = 10h	Based on report submitted. Report should contain observations and calculations based on industry/ lab data.
2.	Technical Video based learning related to the subject	Duration of video = 5h Report preparation = 5h Total = 10h	Report /presentation based on the video learning outcomes.
3.	Assignment writing. Numerical based assignment is preferable.	5 assignments of 4 h each Total = 20h	Based on the correctness of submitted assignment
4.	Problem solving/Coding using C, C++, MATLAB, Python, SCILAB, modeling and Analysis software or any other software	5 small coding-based assignment of 2h each Total = 10h	Based on the coding solution submitted.
5.	Self-learning online course	Minimum duration of the course should be 10h	Examination based assessment at the end of course. Based on the certificate produced.
6.	Identification and solution of Complex problem	Maximum 2 problems. Study of the problem and solution finding, Total = 10h	Based on the depth of the solution submitted.
7	Videos on Industrial safety/Disaster Management aspects based on subject	Duration of video = 5h Report preparation = 5h Total = 10h	Based on quiz/report submitted
8	Technical paper reading and summarization of research papers based on relevant subject	5 research papers = 20h	Summarize research paper and evaluation critical parameters
9.	Poster/chart/power point preparation on technical topics	Duration = 6h	Based on poster/chart preparation and presentation skills
10	Working/non-working model on technical topics	Working = 12h Non- working = 8h	Based on inter department/external evaluation
11	Industrial exposure for 2-3 days to observe and provide tentative solutions on society/environment/health/sustainability/ any other issue	Duration = 15h for industrial exposure Problem identification and tentative solution = 10h Total = 20h	Based on evaluation of critical problems and solutions
12	Group Discussion on emerging/trending technical topics based on subject	Duration = Min. 1h per topic, max. 3h. per topic	Based on performance in group discussion, technical depth, knowledge etc.
13.	Real world case studies-based learning	Duration of data collection/study = 5h Report preparation = 5h Total = 10h	Based on in-depth study, technical depth, data collected, fact finding, etc.
14.	Application/Software development	Duration = 10h	Depending on the complexity of the Application/Software
15.	Research paper publication	Duration = 10h	Based on submission of proof of

			publication
16.	Upgradation/Reverse engineering studies of existing equipment of the laboratory	Duration 10h	Based on the performance of the equipment
17.	Expert lecture/session	Duration 3h For attending the lecture/session– 2h and for report writing 1h	Based on the proof of attendance and report submitted
18.	Annotated Video Explanation of Concept/Problem	10h (Preparation + Recording + Submission)	Based on accuracy of explanation, clarity, and presentation style.
19.	Patent Search and Innovation Gap Identification	10h (Search + Report)	Based on number of relevant patents analyzed and identification of innovation scope.

Note:
1. All the suggested activity should be related to the subject.
2. The number of hours is suggestive. Faculty can sub-divide the number of hours based on the activity. However, total number of hours is fixed.
3. Rubrics for the evaluation can be prepared by the faculty.
4. Subject teacher can add the relevant activities other than those listed above, with the consent of head of the department and DQAC.

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