# GUJARAT TECHNOLOGICAL UNIVERSITY

**BRANCH NAME: Mechanical Engineering**
**SUBJECT NAME: Advance Heat Transfer**
**SUBJECT CODE: 2171911**
**B.E. 7th SEMESTER**

**Type of course:** Elective
**Prerequisite:** Engineering Thermodynamics, Fluid Mechanics, Heat Transfer
**Rationale:** The course is prepared to provide the detailed understanding of conduction, convection, radiation and phase change. This course is design to learn techniques for heat transfer enhancement and usage of numerical methods for solving heat transfer problems.

**Teaching and Examination Scheme:**

| Teaching Scheme | | | Credits | Examination Marks | | | | | | Total Marks |
|---|---|---|---|---|---|---|---|---|---|---|
| L | T | P | C | Theory Marks | | | Practical Marks | | | |
| | | | | ESE (E) | PA (M) | | ESE (V) | | PA (I) | |
| | | | | | PA | ALA | ESE | OEP | | |
| 3 | 0 | 2 | 5 | 70 | 20 | 10 | 20 | 10 | 20 | 150 |

**Content:**

| Sr. No. | Content | No. of Hrs. | % Weightage |
|---|---|---|---|
| 1 | **Heat conduction with heat generation:** Plane wall and cylinder with uniform heat generation, applications. Two-dimensional steady state conduction. | 6 | 14 |
| 2 | **Transient and multi dimensional heat conduction:** Exact solution, use of Heisler and Grober chart, integrated method | 6 | 14 |
| 3 | **Heat Transfer through extended surfaces:** Steady state analysis and optimization, radial fins of rectangular and hyperbolic profiles-longitudinal fin of rectangular profile radiating to free space. | 7 | 17 |
| 4 | **Convective Heat Transfer:**<br>**Forced convection:** Introduction, heat transfer in high velocity flow, empirical relations for pipe and tube flow, flow across cylinders, spheres and tube banks, liquid-metal heat transfer<br>**Natural Convection:** Introduction, empirical relations for free convection, free convection from vertical planes, cylinders, horizontal cylinders, horizontal plates, inclined surfaces, spheres and enclosed space, non-newtonian fluids, combined free and forced convection | 10 | 19 |
| 5 | **Convection with change of phase:**<br>**Condensation:** Laminar film on a vertical surface, Turbulent film on a vertical surface, Film condensation in other configurations, Drop condensation, effect of non-condensable gases in condensing equipments<br>**Boiling:** Pool boiling regimes, Nucleate boiling and peak heat flux, Film boiling and minimum heat flux, Flow boiling | 6 | 17 |
| 6 | **Radiation heat transfer:** Radiation effect on temperature measurements, radiation properties of a participating medium, emissivity and absorptivity of gases and gases mixtures, heat transfer from the human body, radiative exchange and overall heat transfer in furnaces. | 8 | 19 |

**Suggested Specification table with Marks (Theory):**

| Distribution of Theory Marks | | | | | |
|---|---|---|---|---|---|
| R Level | U Level | A Level | N Level | E Level | C Level |
| 10 | 15 | 15 | 15 | 10 | 5 |

**Legends: 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. D.P. Incropera, P.P. and Dewitt, Fundamentals of Heat and Mass Transfer, Wiley Eastern
2. Adrian Bejan, Convective Heat Transfer, Wiley India.
3. Cengel Y A, Heat Transfer – A Practical Approach, McGraw Hill
4. Kays, Crawford and Weigand, Convective Heat and Mass Transfer, McGraw Hill.
5. Siegel and Howell, Thermal Radiation, McGraw Hill.
6. Kraus A.D., Aziz, A., and Welty, J., Extended Surface Heat Transfer, McGraw Hill
7. Adrian Bejan, Allan D. Krams, Heat Transfer Handbook, John Wiley & Sons.
8. J. P. Holman, Heat Transfer, McGraw Hill


**Course Outcome:**

After learning the course, the students should be able to:

- Develop ability to apply the basic principles of classical heat transfer in real engineering application
- Analyze the analytical and numerical solutions for heat transfer problem.
- Understand the basic concepts of turbulence and their impact on heat transfer

**List of Experiments:**

1. Experiment on "Heat transfer through composite wall at different temperature"
2. Experiment on "Thermal conductivity of insulating powder (Asbestos powder) "
3. Experiment on "Heat transfer in turbulent flow"
4. Experiment on "Heat transfer by forced convection"
5. Experiment on "Heat transfer coefficient in natural convection"
6. Experiment on "Heat transfer by radiation: Stefan-Boltzmann Law"
7. Experiment on "Thermal conductivity of metal rod "
8. Experiment on "Drop and Film wise condensation"
9. Experiment on "Unsteady state conduction heat transfer"

**Design based Problems (DP)/Open Ended Problem:**

1. Comparison of composite wall made of different materials
2. Calculate cooling capacity of domestic refrigerator
3. Calculate the effect of different fins in heat transfer

**Major Equipment:**

1. Conduction through Composite Wall
2. Heat Transfer in Natural convection
3. Heat Transfer in Forced Flow
4. Pin-Fin (Natural and Forced Convection)
5. Stefan Boltzmann Constant
6. Emissivity of test plate
7. Drop and Film wise condensation
8. Unsteady state conduction heat transfer

**List of Open Source Software/learning website:**

1. nptel.ac.in
2. www.learnerstv.com
3. cosmolearning.org

**ACTIVE LEARNING ASSIGNMENTS**: Preparation of power-point slides, which include videos, animations, pictures, graphics for better understanding theory and practical work – The faculty will allocate chapters/ parts of chapters to groups of students so that the entire syllabus to be covered. The power-point slides should be put up on the web-site of the College/ Institute, along with the names of the students of the group, the name of the faculty, Department and College on the first slide. The best three works should submit to GTU.