LESSON NOTES

III Year B. Tech II- Semester

MECHANICAL ENGINEERING

HEAT TRANSFER

(15A03603)

SVR Engineering College
Department of Mechanical Engineering
Nandyal-518501
www.svrec.co.in

SVR ENGINEERING COLLEGE

AYYALURMETTA, NANDYAL, KURNOOL (DIST.) – 518503

(Approved by AICTE, New Delhi & Affiliated to JNTUA, Anantapuramu)

CONTENTS

SVR ENGINEERING COLLEGE

AYYALURMETTA, NANDYAL, KURNOOL (DIST.) – 518503

(Approved by AICTE, New Delhi & Affiliated to JNTUA, Anantapuramu)

Vision

To produce Competent Engineering Graduates with a strong base of Technical Knowledge and the Complementary Skills needed to be Successful Professional Engineers.

Mission

To fulfill the vision by imparting Quality Technical Education to the Aspiring Students, by creating Effective Teaching/Learning Environment and providing State – of the – Art Infrastructure and Resources.

SVR ENGINEERING COLLEGE

AYYALURMETTA, NANDYAL, KURNOOL (DIST.) – 518503
(Approved by AICTE, New Delhi & Affiliated to JNTUA, Anantapuramu)

PROGRAM OUTCOMES

Engineering Graduates will be able to:

PO1. An acquisition of basic knowledge related to Thermal Engineering systems like engines, Power Plants, Heat Exchangers, R & AC and Renewable Energy Sources.

PO2. An ability to understand the mechanical systems and analyze the problems related to industrial equipment.

PO3. An ability to design the basic mechanical elements and acquiring the basic design knowledge.

PO4. Acquires the required knowledge in mathematics, physics, chemistry and economics To understand, analyze and solve the complex industrial problems in Mechanical Engineering.

PO5. An ability to apply the advanced Computer Aided Design and analysis software's to find innovative solutions for the industrial problems.

PO6. An ability to analyze the impact of advanced technologies on industrial growth and living standards of society.

PO7. An ability to utilize the machines, man power and raw materials effectively to produce the quality products with minimum cost and minimum pollution.

PO8. A commitment to acquire quality, quantity, time and customer satisfaction with ethics in work culture.

PO9. An ability to take up a project individually and also effectively involve in a team of project.

PO10. Capable enough to communicate with the people in the industry and able to work for the organization as an engineer.

PO11. Acquires knowledge to manage the industry/organization by coordinating the resources like men, machinery and finance.

PO12. Learning basics of various manufacturing processes required to manufacture any

SVR ENGINEERING COLLEGE

AYYALURMETTA, NANDYAL, KURNOOL (DIST.) – 518503

(Approved by AICTE, New Delhi & Affiliated to JNTUA, Anantapuramu)

Programme Educational Objectives of the UG Mechanical Engineering are:

PEO 1: Acquire basic knowledge in the fields of Design and Manufacture of various Mechanical components to meet challenges in Product Design and Manufacturing industries.

PEO 2: To enable to understand, analyze the problems related to thermal engineering systems and industrial engineering problems of any industry.

PEO 3: Use modern computer software tools to solve Mechanical Engineering problems, explain/ defend their solutions and communicate effectively using graphic, verbal, and written techniques to all audience.

SVR ENGINEERING COLLEGE

AYYALURMETTA, NANDYAL, KURNOOL (DIST.) – 518503
(Approved by AICTE, New Delhi & Affiliated to JNTUA, Anantapuramu)

Blooms Taxonomy

Bloom's Taxonomy is a classification of the different objectives and skills that educators set for their students (learning objectives). The terminology has been updated to include the following six levels of learning. These 6 levels can be used to structure the learning objectives, lessons, and assessments of a course.

1. Remembering: Retrieving, recognizing, and recalling relevant knowledge from long- term memory

2. Understanding: Constructing meaning from oral, written, and graphic messages through interpreting, exemplifying, classifying, summarizing, inferring, comparing, and explaining.

3. Applying: Carrying out or using a procedure for executing or implementing.

4. Analyzing: Breaking material into constituent parts, determining how the parts relate to one another and to an overall structure or purpose through differentiating, organizing, and attributing.

5. Evaluating: Making judgments based on criteria and standard through checking and critiquing.

6. Creating: Putting elements together to form a coherent or functional whole; reorganizing elements into a new pattern or structure through generating, planning, or producing.

SVR ENGINEERING COLLEGE

AYYALURMETTA, NANDYAL, KURNOOL (DIST.) – 518503
(Approved by AICTE, New Delhi & Affiliated to JNTUA, Anantapuramu)

Course: IV B. Tech, I Sem (MECH)
Subject: HEAT TRANSFER (17AME45)

Objectives:

1. The students will gain the ability to get an in-depth understanding of the principles governing the transfer of heat, the techniques , tools and skills required to solve typical thermal related problems, the analysis of energy flows in complicated systems and the design of efficient heat transfer equipments. Enables the student to utilize analogies to solve heat transfer problems. Further students gain hands-on experience in heat transfer experimentation through a number of laboratory tests.

Outcomes:

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

1. The concept of steady state conduction. Student can learn representing conduction equation in various forms. Student can imply concept successfully to problems encounter in day to day life .
2. Student is expected understand the concept of extended surfaces and its applications. Also, students can aware transient heat conduction and how it vary w.r.t time.
3. Ability to formulate practical forced and natural convection heat transfer problems by transforming the physical system into a mathematical model.
4. To calculate heat transfer in condensation and boiling systems, turbulent and laminar film condensation. Student can understand the concepts of critical heat flux and different models of critical heat flux.
5. Knowledge on fundamental laws of radiative heat transfer. Also, student can understand the concept of radiative heat transfer between black bodies and grey bodies.

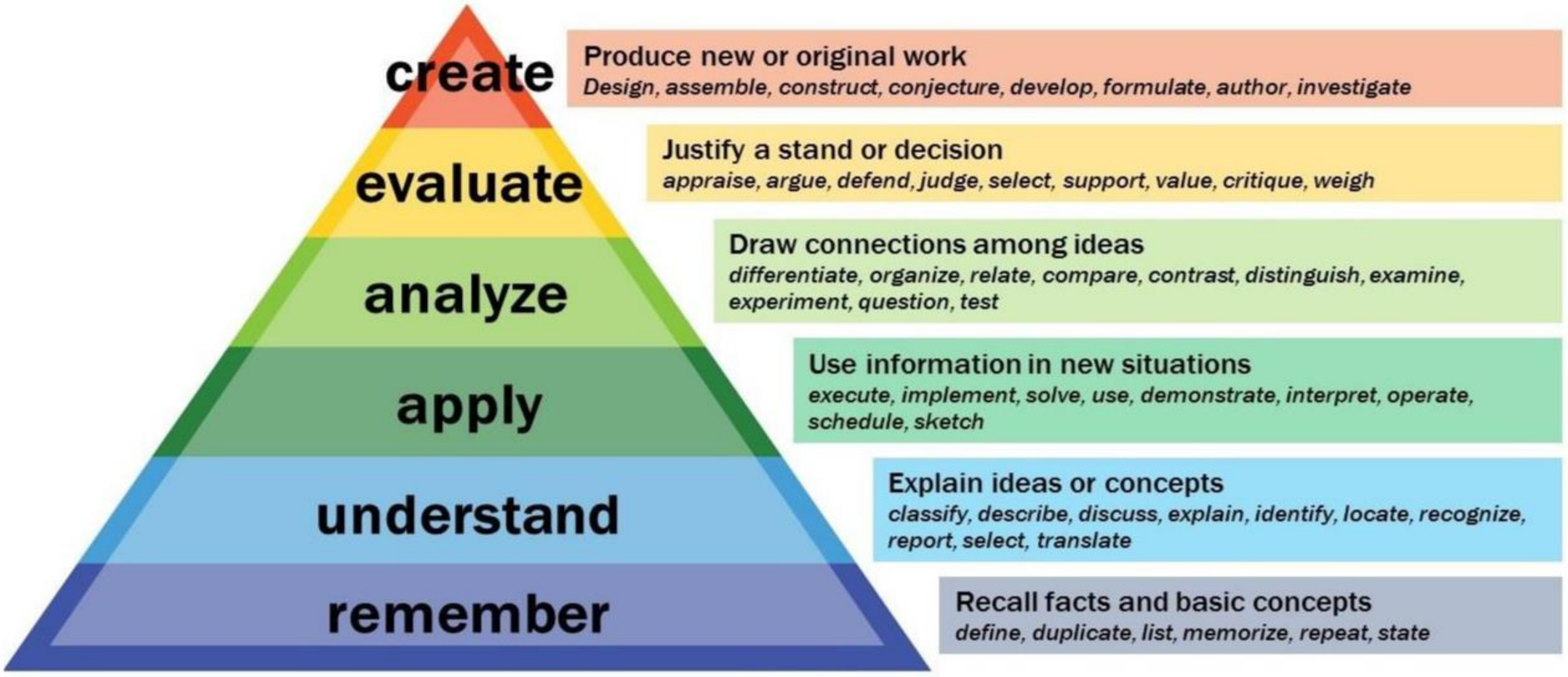
Text Books:

1. R.C. Sachdeva, Heat and Mass Transfer, 5th Edition, New age Publicatio,2017.
2. R.K.Rajput, Heat and Mass Transfer, Concise Edition, S.Chand Publication,2015.

References:

1. Heat Transfer, P.K.Nag, 3/e, TMH, 2011
2. J.P. Holman, Heat transfer, Tata McGraw Hill, 9th Edition,2004.

Note: - Heat and mass transfer data book by C.P. kothandaraman, New age publications is permitted for internal and external examinations.



create
Produce new or original work
Design, assemble, construct, conjecture, develop, formulate, author, investigate
evaluate
Justify a stand or decision
appraise, argue, defend, judge, select, support, value, critique, weigh
analyze
Draw connections among ideas
differentiate, organize, relate, compare, contrast, distinguish, examine, experiment, question, test
apply
Use information in new situations
execute, implement, solve, use, demonstrate, interpret, operate, schedule, sketch
understand
Explain ideas or concepts
classify, describe, discuss, explain, identify, locate, recognize, report, select, translate
remember
Recall facts and basic concepts
define, duplicate, list, memorize, repeat, state

SVR Engineering college
Department of Mechanical Engineering
Nandyal-518501
Course: III B. Tech, II Sem (MECH)
Subject: HEAT TRANSFER (15A03603)

UNIT – I INTRODUCTION: Introduction: Modes and Mechanisms of Heat Transfer – Basic Laws of Heat Transfer – General Applications of Heat Transfer.

Conduction Heat Transfer: Fourier Rate Equation – General Heat Conduction Equation. In Cartesian, Cylindrical and Spherical Coordinates. Simplification and Forms of the Field Equation – Steady, Unsteady and Periodic Heat Transfer – Boundary and Initial Conditions.

One Dimensional Steady State Heat Conduction: In Homogeneous Slabs, Hollow Cylinders and Spheres – Overall Heat Transfer Coefficient – Electrical Analogy – Critical Radius/Thickness of Insulation – With Variable Thermal Conductivity – With Internal Heat Sources or Heat Generation

UNIT – II EXTENDED SURFACES: Heat Transfer in Extended Surface (Fins) – efficiency, effectiveness and temperature distribution on Long Fin, Fin with Insulated Tip and Short Fin, Application to Errors in Temperature Measurement.

TRANSIENT HEAT CONDUCTION: One Dimensional Transient Heat Conduction: In Systems with Negligible Internal Resistance – Significance of Biot and Fourier Numbers – Chart Solutions of Transient Conduction Systems – Problems on Semi-infinite Body

UNIT – III FORCED CONVECTION: Convective Heat Transfer: Dimensional Analysis – Buckingham Π Theorem and Its Application for Developing Semi – Empirical Non-Dimensional Correlations for Convective Heat Transfer – Significance of Non-Dimensional Numbers – Concepts of Continuity, Momentum And Energy Equations.

Forced Convection: External Flows: Concepts of Hydrodynamic and Thermal Boundary Layer and Use of Empirical Correlations for Convective Heat Transfer for Flow Over – Flat Plates, Cylinders and Spheres.

Internal Flows: Division of Internal Flow through Concepts of Hydrodynamic and Thermal Entry Lengths – Use of Empirical Relations for Convective Heat Transfer in Horizontal Pipe Flow, Annular Flow.

Free Convection: Development of Hydrodynamic and Thermal Boundary Layer along a Vertical Plate – Use of Empirical Relations for Convective Heat Transfer on Plates and Cylinders in Horizontal and Vertical Orientation.

UNIT – IV PHASE CHANGE: Boiling: Pool Boiling – Regimes, Determination of Heat Transfer Coefficient in Nucleate Boiling, Critical Heat Flux and Film Boiling.

Condensation: Filmwise and Dropwise Condensation – Nusselt‟s Theory of Condensation on a Vertical Plate – Film Condensation on Vertical and Horizontal Cylinders Using Empirical Correlations.

Heat Exchangers: Classification of Heat Exchangers – Overall Heat Transfer Coefficient and Fouling Factor – Concepts of LMTD and NTU Methods – Problems using LMTD and NTU Methods.

UNIT – V RADIATION HEAT TRANSFER: Radiative Heat Transfer: Emission Characteristics and Laws of Black-Body Radiation – Irradiation – Total and Monochromatic Quantities– Laws of Planck, Wien, Kirchoff, Lambert, Stefan And Boltzmann – Heat Exchange Between Two Black Bodies – Concepts of Shape Factor – Emissivity – Heat Exchange Between Gray Bodies – Radiation Shields – Electrical Analogy for Radiation Networks.

I. INTRODUCTION

Course Contents

- Basic Modes and laws of Heat transfer
- Thermal conductivity
- General conduction equation in Cartesian
- General conduction equation in Cylindrical
- General conduction equation in Spherical coordinates

ONE- DIMENSIONAL STEADY STATE HEAT CONDUCTION:

- Heat flow through plane wall
- Heat flow through Cylinder
- Heat flow through Sphere
- Heat flow through composite slab and Cylinders
- critical insulation thickness

Introduction

Heat is fundamentally transported, or “moved,” by a temperature gradient; it flows or is transferred from a high temperature region to a low temperature one. An understanding of this process and its different mechanisms are required to connect principles of thermodynamics and fluid flow with those of heat transfer.

- Basic Modes and laws of Heat transfer

Heat can be transferred in three different modes: conduction, convection, and radiation. All modes of heat transfer require the existence of a temperature difference, and all modes are from the high-temperature medium to a lower temperature one.