KL UNIVERISTY
FIRST SEMESTER 2010-11
Course Handout
Academic Division

Dated: 07-07-2010

**Course No.** : **BT C204**
**Course Title** : **Fluid Mechanics and Heat Transfer**
**Course Structure** : **3-0-3**
**Course coordinator** : **Ms K Chandrika**
**Instructors** : **Ameer Shaik**

**1. Course Description:**
**T**his theory paper includes basic concepts in fluid flow, transportation methods of fluids. Principles of steady state heat transfer, heat exchange equipments, evaporative methods and Drying materials

**2. Scope and Objective of the Course:**

- Fluids: gases and liquids ,water and air most prevalent in daily experience
- **Examples:** Flow in pipes and channels like air and blood in body, Air resistance like wind Loading, Lubrication, Meteorology and oceanography **Used in the design of** Water supply system for waste water treatment **,**Shock absorbers, brakes automatic transmissions.
- Study of Heat transfer is of great importance to engineers because of its almost universal occurrence in many branches of science and engineering, a thorough heat transfer analysis is most important for the proper sizing of fuel elements in the nuclear reactor
- It is necessary in the refrigeration and air conditioning applications to calculate the heat loads and to determine the Thickness of insulation to avoid excess in heat gains or losses.

**3. Books:**

**(i) Textbook:**

1. **$T_1$** Introduction to chemical engineering –s.k ghosal ,s.k sanyal &datta
2. **$T_2$** Transport processes and unit operations-Christie ,j.geankoplis

**(ii) Reference Book:**

1. R1Unit operations in chemical engineering-w.l mccabe&j.c smith.
2. **$R_2$** :pharmaceutical engineering-c.v.s subrahmanym

**4. Syllabus:**
**UNIT – I: BASIC CONCEPTS IN FLUID FLOW:**

Introduction, basic laws, nature of fluid, viscosity, shear stress, coefficient of viscosity, Newtonian and Non Newtonian fluids, Flow field, Reynolds experiment, Laminar and Turbulent; flow, fluid head, total energy balance for steady flow, Bernoulli's theorem, flow of a fluid past a solid surface. Friction losses in laminar flow through a circular tube (Hagen-Poiseulle equation) Friction losses in turbulent flow (Fanning equation).

**UNIT – II: TRANSPORTATION AND METERING OF FLUIDS:**
**Manometers**: Simple, differential and inclined manometers.
**Hydrodynamic methods**: Pitot tube, orifice and venturimeter, weirs, Rotameters. Centrifugal pump

**UNIT – III: PRINCIPLES OF STEADY STATE HEAT TRANSFER**
Fouriers law of heat conduction, Thermal conductivity, conveetive HTC, conduction through a flat slab as wall, conduction through hollow cylinder, conduction through solids in series, plane walls in series, Log mean temperature difference and varying temperature drop. Introduction and basic equations for radiation.

**UNIT – IV: HEAT EXCHANGE EQUIPMENT AND BASIC CONCEPTS IN EVAPORATION**
**Heat exchangers**: Types of exchangers double-pipe heat exchanger, shell & tube.
**Evaporation**: Introduction, processing factors types of evaporation equipment and evaporation methods-general types of evaporators, methods of operation, overall heat transfer coefficients in evaporators. Heat and material balances for single-effect evaporator.
**Evaporation of Biological materials** – Introduction and properties of Biological materials, Fruit juices, sugar solutions, paper-pulp waste liquors.

**UNIT – V: DRYING OF PROCESS MATERIALS**
Equilibrium moisture content, Bound and unbound moisture, free moisture, rate of drying curves, drying rate curve for constant drying conditions, drying in the constant rate and falling rate periods, calculation methods for constant rate drying and falling rate drying periods.

**5.Course Plan:**

| Lect. No | Learning Objectives | Topics to be Covered | Reference | Chapters |
|---|---|---|---|---|
| 1. | Introduction | Basic laws,material and energy balances | $T_1$ p-15 | Chapter4 |
| 2. | Nature of fluid | Ideal fluid,compressible,incompressible fluids, | $T_1$ P124,126, | Chapter4 |
| 3. | Rheological properties of fluids | viscosity,shear stress | $T_1$ P:127 | Chapter4 |
| 4. | Types of fluids | Newtonian and non Newtonian fluids with examples | $T_1$ P:127-128 | Chapter4 |
| 5. | Flow field | Velocity profile in pipes | $T_1$ P:129,130 | Chapter4 |
| 6. | Laminar & turbulent flow | Velocity profile for Laminar & turbulent flow | $T_1$ P:132,133 | Chapter4 |
| 7. | Total energy balance for steady flow, | Pressure head,velocity head,friction losses & | T1 P:139-140 | Chapter 4 |
| 8 | Bernollis equation | Mechanical energy balances | T1 P:141 | Chapter4 |

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| 9 | Hagen-poisullis equation | Friction loses in laminar flow | $T_1$ P:144 | Chapter4 |
| 10 | Fanning equation | Friction loses in turbulent flow | $T_1$ P:147 | Chapter4 |
| 11 | Manometers | Simple,differential manometers | $T_2$ P:39,40 | Chapter2 |
| 12 | Manometers | Inclined manometers | $T_2$ p:41 | Chapter2 |
| 13. | Manometers | Problems based on manometers(cal.of pressures) | T2 P:42 | Chapter2 |
| 14. | Hydrodynamic methods | Orifice meter,rectangular notch | T2 P:139 | Chapter3 |
| 15. | Hydrodynamic methods | Venturimeter,triangular notch | T2 P:140 | Chapter3 |
| 16. | Hydrodynamic methods | Pitot tube,rotameter, | T2 P:136,142 | Chapter6 |
| 17. | Hydrodynamic methods | centrifugal pump | T2 P:143 | Chapter 3 |
| 18. | Hydrodynamic methods | Problems based on hydrodynamic methods | T2 P:144 | Chapter3 |
| 19. | Laws of heat conduction | Fouriers law,thermal conductivity,convective heat transfer coefficient | T2 P:237,238 | Chapter4 |
| 20. | Conduction through aflat slab as wall and in series | Derivation for heat in terms of temperatures and problems based on that | T2 P:241 | Chapter4 |
| 21. | Conduction through hollow cyllider | Derivation for heat and problems based on that | T2 P:242 | Chapter4 |
| 22. | Conduction through solids in series | Derivation for heat and problems based on that | T2 P:243 | Chapter4 |
| 23. | LMTD | Varying temperatuedrop | T2 P:268 | Chapter4 |
| 24. | radiation | Introduction,nature of thermal radiation | T2 P:301 | Chapter4 |
| 25. | Black body | Absorption,transformation,reflection,and concept of blachk body | T2 P:307 | Chapter5 |
| 26. | Black body radiation | Laws of black body radiation,kirchhoffs law | T2 P312,313 | Chapter5 |

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| 27 | radiation | problems | T2 P:335 | Chapter5 |
| 28. | heatexchangers | Introduction,different types ,LMTD | $T_2$ P:292 | Chapter4 |
| 29. | Shell &tube heat exchangers | Principle,operation and internal parts | $T_2$ P:293 | Chapter4 |
| 30 | double pipe heat exchangers | Principle,operation and internal parts | T2 P:294 | Chapter4 |
| 31. | evaporation | Introduction,proceesing factors,methods of operation,overall h.t.c | T2 P:527 | Chapter8 |
| 32. | Multiple effectevaporators | Feed forward,feed backward effect evaporators | $T_2$ P:529 | Chapter 8 |
| 33 | Single effectevaporatior | Principle,operation,internal parts | T2 P:531 | Chapter8 |
| 34. | Heat and material balances for single effect evaporator | Deivation for heat & problems | $T_2$ P:534 | Chapter 18 |
| 35 | Heat and material balances for single effect evaporator | Deivation for heat & problems | $T_2$ P:535 | Chapter8 |
| 36 | evaporation | problems | T2 P:536 | Chapter8 |
| 37. | Drying, | introduction ,principle.examples,differences between evaporation and drying | T2 P:570 | Chapter9 |
| 37. | drying | Equilibrium moisturecontent,boundand unbound moisture,free moisture | T2 P:572,575 | Chapter9 |
| 38 | Classificatioion of dryers | Solids handling in dyers,temperature patterns in dryers | R1 775,776 | Chapter9 |
| 39 | Drying rate curve | Constant rate curve period | T2 P:578 | Chapter9 |
| 40 | Drying rate curve | Falling rate curve period | T2 P:580,581 | Chapter9 |
| 41 | Calculation method for constant rate pereiod | problems | $T_2$ P:582 | Chapter9 |
| 42 | Calculation method for falling rate period | problems | T2 P:585 | Chapter9 |
| 43 | drying | problems | T2 P:587 | Chapter9 |

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| 44 | Drying equipment | Tray dryers,screen conveyor dryers | T2 P:560,561 | Chapter9 |
| 45 | Drying equipment | Tower dryers,rotary dryers | T2 P:562 | Chapter9 |

**6.Self learning material:**

| Topic | Source | Counselling |
|---|---|---|
| Equation of continuity in three dimensional flow | Unit operations by mc.cabe &smith | - |
| Pressure drop of fluid in pipe | Introduction to chemical engg by ghosal ,sanyal | - |
| piezometers | Mc,cabe &smith | - |
| Orifice plate | Unit operations by mc.cabe &smith | - |
| Conduction through a hollow sphere | Unit operations by mc.cabe &smith | - |
| Mean.H.M,G.P, | Higher engg mathmatics by b.s.grawell | - |
| Plate &frame heat exchanger | Unit operations by mc.cabe &smith | - |
| Individual heat transfer coefficients | Unit operations by Geanoplis | - |
| Applications of evaporators to chemical processes | Unit operations by Geanoplis | - |
| Bound &unbound moisture | Unit operations by Geanoplis | - |
| Types of dryers | Unit operations by Geanoplis | - |

**7.Evaluation Scheme:**

| Component | Duration (minutes) | % Weightage | Marks | Date & Time | Venue |
|---|---|---|---|---|---|
| Test-1 | 50 Min | 6 | 10 | 12.08.2010 09.30 – 10.20 | NSH |
| Test-2 | 50 Min | 6 | 10 | 16.09.2010 09.30 – 10.20 | NSH |
| Assignment submission | | 3 | 5 | Continuous | NSH |
| Assignment Test | 50 Min | 3 | 5 | 28.10.2010 09.00 – 10.20 | NSH |
| Quiz | 30 Min | 3 | 5 | 28.10.2010 09.00 – 10.20 | NSH |
| Regular Lab Evaluation | Continuous | 20 | 50 | | |
| Comprehensive Lab Exam | 3 Hrs | 15 | 40 | | |
| Comprehensive Exam | 3 Hrs | 36 | 60 | | |
| Attendance for Theory & Tutorial | 50 Min | 3 | 5 | Continuous | |
| Attendance for Lab | | 5 | 10 | Continuous | |

**8. Chamber consultation hour:** Informed in the class in first week.

**9. Notices:** All notices regarding the course will be put in E-learning website.

**Course Coordinator**