



SECOND SEMESTER 2020 – 2021

Course Handout part II

Date: 17/01/2021

In addition to part – I (General Handout for all courses appended to the time table) this portion gives further specific details regarding the course.

**Course no:** ME F341  
**Course Title:** PRIME MOVERS AND FLUID MACHINES  
**Instructor – in – charge:** MANOJ KUMAR SONI  
**Lab Instructors:** Mukesh Budaniya, Rahul Ukey, Harsh Sharma, Vishwjeet Choudhary

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

The Course is intended to familiarize the students with theoretical analysis of energy and momentum transfer between the fluid and rotor. The working principles, design considerations, performance and application aspects of turbo machines will be dealt with. Classification, descriptive details and performance of rotary machines and reciprocating machines will be discussed.

**2. Text books:**

- TB1:** Agarwall S K; Fluid Mechanics and Machinery; Tata McGrawhill publishing company limited, New Delhi; 1997.  
**TB2:** Kadambi V & Manohar Prasad; An Introduction to Energy Conversion Volume III; New Age International (P) limited; 1977.  
**TB2:** S. S. Deshmukh & M. S. Soni; Laboratory manual for prime movers and fluid machines; EDD notes.

**Reference Books:**

- RB1:** Jagdish Lal; Hydraulic Machines; Metropolitan Book Company Private limited, New Delhi; 1975; 6<sup>th</sup> Edition.

**3. Course Objectives:**

| No  | Course Objectives  |
|-----|--|
| CO1 | To understand dimensional analysis and perform dimensional analysis using suitable technique for a given problem statement |





|     |  |
|-----|--|
| CO2 | To understand model analysis of fluid machines.  |
| CO3 | To understand theory and working principles of fluid machines  |
| CO4 | The understand the theoretical analysis of energy and momentum transfer between the fluid and rotor. |
| CO5 | The understand the theoretical analysis of positive displacement machines.                           |
| CO6 | To understand design considerations, performance and application aspects of various turbo machines.  |

#### 4. Course Learning Outcomes:

| No  | Learning Outcomes   |
|-----|---|
| LO1 | To perform dimensional and model analysis for a given problem statement                 |
| LO2 | To explain working principles of fluid machines   |
| LO3 | The analyse energy and momentum transfer between the fluid and rotor of fluid machines. |
| LO4 | The analyse positive displacement machines.   |
| LO5 | To evaluate the performance of various turbo machines under given conditions.           |

#### 5. Modular Content Structure:

| Week No. | Learning Objectives   | Sub-modules (SM)   | Reference to Text books                                 |
|----------|---|--|---|
| M1       | Introduction, To understand Dimensional analysis as applied to fluid machines. To understand the principles of similarity and model testing | SM1.1: Units and Dimensions<br>SM1.2: Methods of Dimensional Analysis<br>SM1.3: Dimensionless Numbers<br>SM1.4: Similarity<br>SM1.5: Unit Quantities<br>SM1.6: Specific Quantities<br>SM1.7: Dimensional Analysis for Rotating Systems<br>SM1.8: Model Testing of Turbines and Pumps | Chapter 12 of RB1;<br>Chapter 16 of TB1;<br>Class notes |





| Week No. | Learning Objectives  | Sub-modules (SM)  | Reference to Text books                                 |
|----------|--|---|---|
| M2       | To review the basic concepts of fluid mechanics and machinery. To understand the classification of hydraulic turbines To analyse the hydraulic machine | SM2.1: Elements of a Hydroelectric Power Plant<br>SM2.2: Classification of Turbines<br>SM2.3: Head and Efficiencies of a Turbine<br>SM2.4: Energy Conversion<br>SM2.5: Fundamental Equation of Hydraulic Machines<br>SM2.6: Pelton Turbine<br>SM2.7: Francis Turbine<br>SM2.8: Axial Flow Turbines<br>SM2.9: Kaplan Turbine<br>SM2.10: Governing of Water Turbines<br>SM2.11: Characteristics of Turbines<br>SM2.12: Selection of Turbines  | Chapter 13 of TB1;<br>Chapter 18 of RB1;<br>Class notes |
| M3       | To understand the classification of pumps, working principles of various pumps, Analysis of reciprocating pumps.                                       | SM3.1: Classification of Reciprocating Pumps<br>SM3.2: Velocity and Acceleration of Water in Suction and Delivery Pipes<br>SM3.3: Indicator Diagram<br>SM3.4: Effect of Acceleration Head in Suction and Delivery Pipe on Indicator Diagram<br>SM3.5: Effect of Pipe Friction on Indicator Diagram<br>SM3.6: Effect of Acceleration Head and Pipe Friction on Indicator Diagram<br>SM3.7: Limitation on Maximum Speed of Reciprocating Pump<br>SM3.8: Air Vessels<br>SM3.9: Effect of Air Vessel on Indicator Diagram<br>SM3.10: Work Saved with Air Vessel | Chapter 14 of TB1;<br>Chapter 20 of RB1;<br>Class notes |
| M4       | To understand the analytical principles of centrifugal pumps   | SM4.1: Centrifugal Pump System<br>SM4.2: Classification of Centrifugal Pumps<br>SM4.3: Fundamental Equation of Centrifugal Pump<br>SM4.4: Power and Efficiency<br>SM4.5: Minimum starting speed of the pump<br>SM4.6: Variation of Euler Head with Curvature of Blades<br>SM4.7: Maximum Suction Height<br>SM4.8: Net Positive Suction Head (NPSH)<br>SM4.9: Characteristics of a Centrifugal Pump  | Chapter 14 of TB1;<br>Chapter 19 of RB1;<br>Class notes |





| Week No. | Learning Objectives  | Sub-modules (SM)   | Reference to Text books                                |
|----------|--|--|--|
| M5       | To understand classification; working & analytical principles of Reciprocating compressors.                        | SM5.1: Classification Of Compressors<br>SM5.2: Reciprocating Compressor<br>SM5.3: Volumetric Efficiency<br>SM5.4: Multi-stage Compression with Inter-cooling   | Chapter 15 of TB1;<br>Class notes                      |
| M6       | To understand the analytical principles of centrifugal compressors and various other compressors                   | SM6.1: Main Components of centrifugal compressor<br>SM6.2: Energy Conversion<br>SM6.3: Slip and Slip factor<br>SM6.4: Impeller Vane Shape and Velocity Triangles<br>SM6.5: Stagnation Values in Centrifugal Compressor<br>SM6.6: Rothalpy<br>SM6.7: Pressure Coefficient<br>SM6.8: Surging and Stalling<br>SM6.9: Centrifugal compressor characteristics<br>SM6.10: Fans and Blowers                                   | Chapter 15 of TB1;<br>chapter 5 of TB2;<br>Class notes |
| M7       | To understand the analytical principles of axial compressors and various other compressors                         | SM7.1: Introduction<br>SM7.2: Axial Flow Compressor<br>SM7.3: Cascade Flow and Nomenclature<br>SM7.4: Stage Velocity Triangles and Work Input<br>SM7.5: Effect of Axial velocity on Work<br>SM7.6: Degree of Reaction<br>SM7.7: Small Stage or Polytropic Efficiency<br>SM7.8: Stage loading coefficient<br>SM7.9: Surging<br>SM7.10: Stalling<br>SM7.11: Axial Compressor Characteristics<br>SM7.12: Fans and Blowers | Chapter 15 of TB1;<br>chapter 5 of TB2;<br>Class notes |
| M8       | To understand thermodynamic and analytical principles behind the flow of fluids through nozzles and blade passages | SM8.1: Introduction<br>SM8.2: Flow of Steam through nozzles<br>SM8.3: Critical Pressure Ratio and Maximum Discharge<br>SM8.4: Expansion of Steam Considering Friction (Nozzle Efficiency)<br>SM8.5: Supersaturated or Meta stable flow of steam in nozzle  | Chapter 3 of TB2;<br>Class notes                       |





| Week No. | Learning Objectives   | Sub-modules (SM)   | Reference to Text books          |
|----------|---|--|----------------------------------|
| M9       | To understand the classification of steam turbines and basic principles of analysis<br>To understand the analysis of various steam turbines | SM9.1: Introduction<br>SM9.2: Classification of Steam Turbines<br>SM9.3: Impulse Turbine<br>SM9.4: Reaction Turbine (Impulse Reaction Turbine)<br>SM9.5: Stage Efficiency, Turbine Efficiency and Reheat Factor<br>SM9.6: Losses in Steam Turbines<br>SM9.7: Governing of Steam Turbines | Chapter 4 of TB2;<br>Class notes |
| M10      | To understand classification; working & analytical principles of gas turbines   | SM10.1: Introduction to gas turbines<br>SM10.2: Elementary Design of a turbine<br>SM10.3: Off Design Parameters<br>SM10.4: Three Dimensional Flows<br>SM10.5: Gas Turbine Blading  | Chapter 4 of TB2;<br>Class notes |

## 6. Learning Plan

### Contact Hour 1

| Type      | Content Ref.                     | Topic Title  | Study/HW Resource Reference                             |
|-----------|----------------------------------|--|---|
| Pre CH    |                                  |  |   |
| During CH | SM2.1<br>SM2.2<br>SM2.3<br>SM2.4 | Introduction<br>SM2.1: Elements of a Hydroelectric Power Plant<br>SM2.2: Classification of Turbines<br>SM2.3: Head and Efficiencies of a Turbine<br>SM2.4: Energy Conversion | Chapter 13 of TB1;<br>Chapter 18 of RB1;<br>Class notes |
| Post CH   |                                  | Revise the content taught during CH1   |   |

### Contact Hour 2

| Type   | Content Ref. | Topic Title                          | Study/HW Resource Reference |
|--------|--------------|--------------------------------------|-----------------------------|
| Pre CH |              | Revise the content taught during CH1 |                             |





|           |                |  |   |
|-----------|----------------|--|---|
| During CH | SM2.5<br>SM2.6 | SM2.5: Fundamental Equation of Hydraulic Machines<br>SM2.6: Pelton Turbine | Chapter 13 of TB1;<br>Chapter 18 of RB1;<br>Class notes |
| Post CH   |                | Revise the content taught during CH2                                       |   |

#### Contact Hour 3

| Type      | Content Ref.   | Topic Title  | Study/HW Resource Reference                             |
|-----------|----------------|--|---|
| Pre CH    |                | Revise the content taught during CH2                 |   |
| During CH | SM2.7<br>SM2.8 | SM2.7: Francis Turbine<br>SM2.8: Axial Flow Turbines | Chapter 13 of TB1;<br>Chapter 18 of RB1;<br>Class notes |
| Post CH   |                | Revise the content taught during CH3                 |   |

#### Contact Hour 4

| Type      | Content Ref.                        | Topic Title   | Study/HW Resource Reference                             |
|-----------|-------------------------------------|---|---|
| Pre CH    |                                     | Revise the content taught during CH3  |   |
| During CH | SM2.9<br>SM2.10<br>SM2.11<br>SM2.12 | SM2.9: Kaplan Turbine<br>SM2.10: Governing of Water Turbines<br>SM2.11: Characteristics of Turbines<br>SM2.12: Selection of Turbines<br>Problems discussion | Chapter 13 of TB1;<br>Chapter 18 of RB1;<br>Class notes |
| Post CH   |                                     | Revise the content taught during CH4  |   |

#### Contact Hour 5

| Type      | Content Ref.   | Topic Title                                  | Study/HW Resource Reference              |
|-----------|----------------|--|--|
| Pre CH    |                | Revise the content taught during CH4         |  |
| During CH | SM3.1<br>SM3.2 | SM3.1: Classification of Reciprocating Pumps | Chapter 14 of TB1;<br>Chapter 20 of RB1; |





|         |       |   |             |
|---------|-------|---|-------------|
|         | SM3.3 | SM3.2: Velocity and Acceleration of Water in Suction and Delivery Pipes<br>SM3.3: Indicator Diagram | Class notes |
| Post CH |       | Revise the content taught during CH5  |             |

#### Contact Hour 6

| Type      | Content Ref.   | Topic Title   | Study/HW Resource Reference                             |
|-----------|----------------|---|---|
| Pre CH    |                | Revise the content taught during CH5  |   |
| During CH | SM3.4<br>SM3.5 | SM3.4: Effect of Acceleration Head in Suction and Delivery Pipe on Indicator Diagram<br>SM3.5: Effect of Pipe Friction on Indicator Diagram | Chapter 14 of TB1;<br>Chapter 20 of RB1;<br>Class notes |
| Post CH   |                | Revise the content taught during CH6  |   |

#### Contact Hour 7

| Type      | Content Ref.   | Topic Title   | Study/HW Resource Reference                             |
|-----------|----------------|---|---|
| Pre CH    |                | Revise the content taught during CH6  |   |
| During CH | SM3.6<br>SM3.7 | SM3.6: Effect of Acceleration Head and Pipe Friction on Indicator Diagram<br>SM3.7: Limitation on Maximum Speed of Reciprocating Pump | Chapter 14 of TB1;<br>Chapter 20 of RB1;<br>Class notes |
| Post CH   |                | Revise the content taught during CH7  |   |

#### Contact Hour 8

| Type   | Content Ref. | Topic Title                          | Study/HW Resource Reference |
|--------|--------------|--------------------------------------|-----------------------------|
| Pre CH |              | Revise the content taught during CH7 |                             |







|           |                          |   |   |
|-----------|--------------------------|---|---|
| During CH | SM3.8<br>SM3.9<br>SM3.10 | SM3.8: Air Vessels<br>SM3.9: Effect of Air Vessel on Indicator Diagram<br>SM3.10: Work Saved with Air Vessel<br>Problems discussion | Chapter 14 of TB1;<br>Chapter 20 of RB1;<br>Class notes |
| Post CH   |                          | Revise the content taught during CH8  |   |

#### Contact Hour 9

| Type      | Content Ref.            | Topic Title   | Study/HW Resource Reference                             |
|-----------|-------------------------|---|---|
| Pre CH    |                         | Revise the content taught during CH8  |   |
| During CH | SM4.1<br>SM4.2<br>SM4.3 | SM4.1: Centrifugal Pump System<br>SM4.2: Classification of Centrifugal Pumps<br>SM4.3: Fundamental Equation of Centrifugal Pump | Chapter 14 of TB1;<br>Chapter 19 of RB1;<br>Class notes |
| Post CH   |                         | Revise the content taught during CH9  |   |

#### Contact Hour 10

| Type      | Content Ref.            | Topic Title   | Study/HW Resource Reference                             |
|-----------|-------------------------|---|---|
| Pre CH    |                         | Revise the content taught during CH9  |   |
| During CH | SM4.4<br>SM4.5<br>SM4.6 | SM4.4: Power and Efficiency<br>SM4.5: Minimum starting speed of the pump<br>SM4.6: Variation of Euler Head with Curvature of Blades | Chapter 14 of TB1;<br>Chapter 19 of RB1;<br>Class notes |
| Post CH   |                         | Revise the content taught during CH10   |   |

#### Contact Hour 11

| Type   | Content Ref. | Topic Title                           | Study/HW Resource Reference |
|--------|--------------|---------------------------------------|-----------------------------|
| Pre CH |              | Revise the content taught during CH10 |                             |







|           |                         |   |   |
|-----------|-------------------------|---|---|
| During CH | SM4.7<br>SM4.8<br>SM4.9 | SM4.7: Maximum Suction Height<br>SM4.8: Net Positive Suction Head (NPSH)<br>SM4.9: Characteristics of a Centrifugal Pump<br>Problems discussion | Chapter 14 of TB1;<br>Chapter 19 of RB1;<br>Class notes |
| Post CH   |                         | Revise the content taught during CH11   |   |

#### Contact Hour 12

| Type      | Content Ref.   | Topic Title   | Study/HW Resource Reference       |
|-----------|----------------|---|-----------------------------------|
| Pre CH    |                | Revise the content taught during CH11                                   |                                   |
| During CH | SM5.1<br>SM5.2 | SM5.1: Classification Of Compressors<br>SM5.2: Reciprocating Compressor | Chapter 15 of TB1;<br>Class notes |
| Post CH   |                | Revise the content taught during CH12                                   |                                   |

#### Contact Hour 13

| Type      | Content Ref.   | Topic Title  | Study/HW Resource Reference       |
|-----------|----------------|--|-----------------------------------|
| Pre CH    |                | Revise the content taught during CH12  |                                   |
| During CH | SM5.3<br>SM5.4 | SM5.3: Volumetric Efficiency<br>SM5.4: Multi-stage Compression with Inter-cooling<br>Problems discussion | Chapter 15 of TB1;<br>Class notes |
| Post CH   |                | Revise the content taught during CH13  |                                   |

#### Contact Hour 14

| Type      | Content Ref.   | Topic Title  | Study/HW Resource Reference                            |
|-----------|----------------|--|--|
| Pre CH    |                | Revise the content taught during CH13  |  |
| During CH | SM6.1<br>SM6.2 | SM6.1: Main Components of centrifugal compressor<br>SM6.2: Energy Conversion | Chapter 15 of TB1;<br>chapter 5 of TB2;<br>Class notes |





|         |                         |  |  |
|---------|-------------------------|--|--|
|         | SM6.3<br>SM6.4<br>SM6.5 | SM6.3: Slip and Slip factor<br>SM6.4: Impeller Vane Shape and Velocity Triangles<br>SM6.5: Stagnation Values in Centrifugal Compressor |  |
| Post CH |                         | Revise the content taught during CH14  |  |

#### Contact Hour 15

| Type      | Content Ref.            | Topic Title   | Study/HW Resource Reference                            |
|-----------|-------------------------|---|--|
| Pre CH    |                         | Revise the content taught during CH14   |  |
| During CH | SM6.6<br>SM6.7<br>SM6.8 | SM6.6: Rothalpy<br>SM6.7: Pressure Coefficient<br>SM6.8: Surging and Stalling | Chapter 15 of TB1;<br>Chapter 5 of TB2;<br>Class notes |
| Post CH   |                         | Revise the content taught during CH15   |  |

#### Contact Hour 16

| Type      | Content Ref.    | Topic Title  | Study/HW Resource Reference                            |
|-----------|-----------------|--|--|
| Pre CH    |                 | Revise the content taught during CH15  |  |
| During CH | SM6.9<br>SM6.10 | SM6.9: Centrifugal compressor characteristics<br>SM6.10: Fans and Blowers<br>Problems discussion | Chapter 15 of TB1;<br>Chapter 5 of TB2;<br>Class notes |
| Post CH   |                 | Revise the content taught during CH16  |  |

#### Contact Hour 17

| Type   | Content Ref. | Topic Title                           | Study/HW Resource Reference |
|--------|--------------|---------------------------------------|-----------------------------|
| Pre CH |              | Revise the content taught during CH16 |                             |





|           |                                  |   |  |
|-----------|----------------------------------|---|--|
| During CH | SM7.1<br>SM7.2<br>SM7.3<br>SM7.4 | SM7.1: Introduction<br>SM7.2: Axial Flow Compressor<br>SM7.3: Cascade Flow and Nomenclature<br>SM7.4: Stage Velocity Triangles and Work Input | Chapter 15 of TB1;<br>Chapter 5 of TB2;<br>Class notes |
| Post CH   |                                  | Revise the content taught during CH17   |  |

#### Contact Hour 18

| Type      | Content Ref.  | Topic Title   | Study/HW Resource Reference                            |
|-----------|---|---|--|
| Pre CH    |   | Revise the content taught during CH17   |  |
| During CH | SM7.5<br>SM7.6<br>SM7.7<br>SM7.8<br>SM7.9<br>SM7.10 | SM7.5: Effect of Axial velocity on Work<br>SM7.6: Degree of Reaction<br>SM7.7: Small Stage or Polytropic Efficiency<br>SM7.8: Stage loading coefficient<br>SM7.9: Surging<br>SM7.10: Stalling | Chapter 15 of TB1;<br>Chapter 5 of TB2;<br>Class notes |
| Post CH   |   | Revise the content taught during CH18   |  |

#### Contact Hour 19

| Type      | Content Ref.     | Topic Title   | Study/HW Resource Reference                            |
|-----------|------------------|---|--|
| Pre CH    |                  | Revise the content taught during CH18   |  |
| During CH | SM7.11<br>SM7.12 | SM7.11: Axial Compressor Characteristics<br>SM7.12: Fans and Blowers<br>Problems discussion | Chapter 15 of TB1;<br>Chapter 5 of TB2;<br>Class notes |
| Post CH   |                  | Revise the content taught during CH19   |  |

#### Contact Hour 20

| Type   | Content Ref. | Topic Title                           | Study/HW Resource Reference |
|--------|--------------|---------------------------------------|-----------------------------|
| Pre CH |              | Revise the content taught during CH19 |                             |





|           |                         |   |                                  |
|-----------|-------------------------|---|----------------------------------|
| During CH | SM8.1<br>SM8.2<br>SM8.3 | SM8.1: Introduction<br>SM8.2: Flow of Steam through nozzles<br>SM8.3: Critical Pressure Ratio and Maximum Discharge | Chapter 3 of TB2;<br>Class notes |
| Post CH   |                         | Revise the content taught during CH20   |                                  |

#### Contact Hour 21

| Type      | Content Ref.   | Topic Title  | Study/HW Resource Reference      |
|-----------|----------------|--|----------------------------------|
| Pre CH    |                | Revise the content taught during CH20  |                                  |
| During CH | SM8.4<br>SM8.5 | SM8.4: Expansion of Steam Considering Friction (Nozzle Efficiency)<br>SM8.5: Supersaturated or Meta stable flow of steam in nozzle | Chapter 3 of TB2;<br>Class notes |
| Post CH   |                | Revise the content taught during CH21  |                                  |

#### Contact Hour 22

| Type      | Content Ref.                     | Topic Title  | Study/HW Resource Reference      |
|-----------|----------------------------------|--|----------------------------------|
| Pre CH    |                                  | Revise the content taught during CH21  |                                  |
| During CH | SM9.1<br>SM9.2<br>SM9.3<br>SM9.4 | SM9.1: Introduction<br>SM9.2: Classification of Steam Turbines<br>SM9.3: Impulse Turbine<br>SM9.4: Reaction Turbine (Impulse Reaction Turbine) | Chapter 4 of TB2;<br>Class notes |
| Post CH   |                                  | Revise the content taught during CH22  |                                  |

#### Contact Hour 23

| Type | Content Ref. | Topic Title | Study/HW Resource Reference |
|------|--------------|-------------|-----------------------------|
|      |              |             |                             |





|           |                         |   |                                  |
|-----------|-------------------------|---|----------------------------------|
| Pre CH    |                         | Revise the content taught during CH22   |                                  |
| During CH | SM9.5<br>SM9.6<br>SM9.7 | SM9.5: Stage Efficiency, Turbine Efficiency and Reheat Factor<br>SM9.6: Losses in Steam Turbines<br>SM9.7: Governing of Steam Turbines<br>Problems discussion | Chapter 4 of TB2;<br>Class notes |
| Post CH   |                         | Revise the content taught during CH23   |                                  |

#### Contact Hour 24

| Type      | Content Ref.               | Topic Title   | Study/HW Resource Reference      |
|-----------|----------------------------|---|----------------------------------|
| Pre CH    |                            | Revise the content taught during CH23   |                                  |
| During CH | SM10.1<br>SM10.2<br>SM10.3 | SM10.1: Introduction to gas turbines<br>SM10.2: Elementary Design of a turbine<br>SM10.3: Off Design Parameters | Chapter 4 of TB2;<br>Class notes |
| Post CH   |                            | Revise the content taught during CH24   |                                  |

#### Contact Hour 25

| Type      | Content Ref.     | Topic Title  | Study/HW Resource Reference      |
|-----------|------------------|--|----------------------------------|
| Pre CH    |                  | Revise the content taught during CH24                          |                                  |
| During CH | SM10.4<br>SM10.5 | SM10.4: Three Dimensional Flows<br>SM10.5: Gas Turbine Blading | Chapter 4 of TB2;<br>Class notes |
| Post CH   |                  | Revise the content taught during CH25                          |                                  |

#### Contact Hour 26

| Type | Content Ref. | Topic Title | Study/HW Resource Reference |
|------|--------------|-------------|-----------------------------|
|      |              |             |                             |





|           |                         |  |   |
|-----------|-------------------------|--|---|
| Pre CH    |                         | Revise the content taught during CH25  | Chapter 1 of TB1  |
| During CH | SM1.6<br>SM1.7<br>SM1.8 | SM1.6: Specific Quantities<br>SM1.7: Dimensional Analysis for Rotating Systems<br>SM1.8: Model Testing of Turbines and Pumps | Chapter 12 of RB1;<br>Chapter 16 of TB1;<br>Class notes |
| Post CH   |                         | Revise the content taught during CH26  |   |

### 7. Course plan:

| Lect Nos. | Learning Objectives  | Topics to be covered   | Reference   |
|-----------|--|--|-------------|
| 1-2       | Introduction to the course, To review the basic concepts of fluid mechanics and machinery. To understand the classification of hydraulic turbines; principles of analysis. | Introduction, Elements of a Hydroelectric Power Plant, Classification of Turbines, Head and Efficiencies of a Turbine, Energy Conversion, Fundamental Equation of Hydraulic Machines   | Class notes |
| 3-4       | To understand the analytical principles of various hydraulic turbines.   | Pelton Turbine, Francis Turbine, Axial Flow Turbines, Kaplan Turbine, Governing of Water Turbines, Characteristics of Turbines, Selection of Turbines  | Class notes |
| 5-8       | To understand the classification of pumps, working principles of various pumps, Analysis of reciprocating pumps.   | Introduction; reciprocating pumps, Classification, Slip, Velocity and Acceleration of Water in Suction and Delivery Pipes, Indicator Diagram, Effect of Acceleration Head, Effect of Pipe Friction, Limitation on Maximum Speed of Reciprocating Pump, Air Vessels, Effect of Air Vessel, Work Saved with Air Vessel | Class notes |
| 9-11      | To understand the analytical principles of centrifugal pumps   | Classification, Fundamental Equation, Curvature of Blades, Variation in Speed and Diameter of a Centrifugal Pump, Characteristics of a Centrifugal Pump  | Class notes |
| 12-13     | To understand classification; working & analytical principles of various compressors.  | Introduction; classification; reciprocating compressors; Multi stage compression with inter cooling  | Class notes |





| Lect Nos. | Learning Objectives   | Topics to be covered  | Reference   |
|-----------|---|---|-------------|
| 14-16     | To understand the analytical principles of centrifugal compressors  | Velocity Triangles , Slip , Influence of Impeller Blade Shape, Stagnation Values in Centrifugal Compressor, Pressure Coefficient, Rothalpy, Surging and Stalling, Centrifugal Compressor Characteristics,   | Class notes |
| 17-19     | To understand the analytical principles of Axial flow compressors and various other compressors                     | Cascade Flow and Nomenclature, Velocity Triangles, Work Done and Degree of Reaction, Effect of Axial velocity on Work, Degree of Reaction, Small Stage or Polytropic Efficiency, Stage Loading Coefficient , Surging, Stalling and Rotating Stall, Axial Compressor Characteristics | Class notes |
| 20-21     | To understand thermodynamic and analytical principles behind the flow of fluids through nozzles and blade passages. | Introduction, Flow of Steam Through Nozzles , Critical Pressure Ratio And Maximum Discharge , Expansion of Steam Considering Friction (Nozzle Efficiency), Supersaturated or Meta Stable Flow of Steam in Nozzle;   | Class notes |
| 22-23     | To understand the classification of steam turbines and basic principles of analysis.                                | Introduction, Classification of Steam Turbines, Impulse Turbine, Reaction Turbine (Impulse Reaction Turbine), Stage Efficiency, Turbine Efficiency and Reheat Factor, Losses in Steam Turbines;, Governing of Steam Turbines  | Class notes |
| 24-25     | To understand classification; working & analytical principles of gas turbines.                                      | Introduction, Elementary Design of a turbine, Off Design Parameters, Three Dimensional Flows, Gas Turbine Blading; numerical problems.  | Class notes |
| 26        | To understand Dimensional analysis as applied to fluid machines.  | Dimensional Analysis, Dimensionless Numbers, Similarity, Unit Quantities, Specific Quantities, Dimensional Analysis for Rotating Systems, Model Testing of Turbines and Pumps   | Class notes |

### 8. Reading assignments:

Time to time reading assignments will be given to the students. These reading assignments are part of the course and questions may appear in tests/examinations in these portions also.







## 9. Evaluation Scheme:

### Existing:

| Component                 | Duration | Weightage | Date & Time            | Remarks                              |
|---------------------------|----------|-----------|------------------------|--------------------------------------|
| Mid Sem                   | 90 min   | 25%       |                        | Online                               |
| Online Quiz               | 50 min   | 20%       | Lecture hour/announced | Two online quizzes will be conducted |
| Lab Compre                | 2 hrs    | 10%       | Announced later        |                                      |
| Lab Reports               |          | 5%        | During lab hours       |                                      |
| Lab Group Discussion/Viva |          | 10%       | During lab hours       |                                      |
| Compre                    | 3 hours  | 30%       | 12th May 2021<br>FN    | CB                                   |

**10. Chamber Consultation hours:** To be announced in the class.

**11. Notices:** All the notices related to this course will be put up put up on Nalanda only.

**12. Make up Policy:** Make up will be given to only to genuine cases. The request application should reach the Instructor – in – charge before commencement of scheduled test.

**13. Laboratory Experiments:** Following is the final list of experiments.

Cycle 1:

1. Characteristics of Centrifugal Pump.
2. A) Valve timing diagram on Petrol Engine, B) Valve timing diagram on Diesel Engine.
3. Coordinating fuel Research Engine.
4. Characteristics of Francis Turbine.
5. Verification of Fans laws.

Cycle 2:

1. Characteristics of Pelton Turbine.
2. Characteristics of Kaplan Turbine.
3. Petrol Engine with eddy current dynamometer (Morse test).
4. Performance test on Air Compressor
5. Dismantling & Assembling of Water Pump.

Instructor – in Charge/ME F341

