

FLUID MACHINES

ENME 302

Lecture : 3
Tutorial : 1
Practical : 3/2

Year : III
Part : I

Course Objectives:

The objective of this course is to provide concepts of fluid force and power on fluid machinery. It covers the general introductory part of a hydropower plant. It deals with water turbines, water pumps, steam turbines, and the working of hydraulic machines.

- 1 Turbomachine and Dynamic Action of Fluid (8 hours)**
 - 1.1 Turbomachines and hydraulic machines: Introduction and classification
 - 1.2 History of development of water wheels and water turbines
 - 1.3 Review of linear momentum and impulse equations
 - 1.4 Dynamic force exerted by fluid jet
 - 1.5 Stationary and moving plates, flat and curved surfaces
 - 1.6 Jet propulsion principle; Boat and ship propulsion

- 2 Hydroelectric Plant (5 hours)**
 - 2.1 Essential components and features
 - 2.2 Potential and useful power from a plant
 - 2.3 Classification of hydroelectric plants
 - 2.4 Hydroelectric power plants in Nepal

- 3 Water Turbines (16 hours)**
 - 3.1 Classification of water turbines on different bases
 - 3.2 Pelton, Francis, Kaplan, Propeller, and cross-flow turbines: Working principles, components, and their functions
 - 3.3 Draft tubes: Types and theory
 - 3.4 Specific speed, efficiency
 - 3.5 Performance characteristics (Main, operating, and ISO efficiency curve)
 - 3.6 Selection of turbine
 - 3.7 Design of Pelton, Francis, and Propeller Turbines
 - 3.8 Governor: Concepts and classification
 - 3.9 Oil pressure governor: Components, working principle

- 4 Water Pumps (10 hours)**
 - 4.1 Classification
 - 4.2 Centrifugal pump: Working principle, components, application

- 4.3 Reciprocating pump: Working principle, components, application
- 4.4 Pump as turbine (PAT): Working principles, components, application
- 4.5 Specific speed, head, power, efficiency, velocity triangle
- 4.6 Net positive suction head (NPSH) and priming
- 4.7 Series and parallel combination of pumps
- 4.8 Pump characteristics curve (Head, flow, power, efficiency curve),
- 4.9 Energy loss, cavitation, and the effect of viscosity in pumping
- 4.10 Pump slip and efficiency
- 4.11 Indicator diagrams
- 4.12 Selection of pumps

5 Steam Turbine (4 hours)

- 5.1 Pipe nozzle: Types, working, energy equation
- 5.2 Steam turbine classification: Impulse and reaction
- 5.3 De-Laval and Parsons turbine: Working, components, efficiency, velocity triangles

6 Working of Hydraulic Machine (2 hours)

- 6.1 Hydraulic ram
- 6.2 Air lift pump
- 6.3 Hydraulic lift
- 6.4 Hydraulic press
- 6.5 Hydraulic accumulator
- 6.6 Hydraulic torque converter

Tutorial (15 hours)

- 1. Numerical of dynamic action of fluid
- 2. Numerical of water turbines, water pumps and hydraulic machine
- 3. Design of Pelton turbine and Francis turbine

Practical (22.5 hours)

- 1. Performance analysis of positive displacement pumps
- 2. Performance analysis of Roto-dynamic pumps
- 3. Performance analysis of the series and parallel combination of pumps
- 4. Performance analysis of the Pelton turbine
- 5. Performance analysis of the Francis turbine
- 6. Performance testing of the steam turbine

Visual presentation/demonstration/observation of a hydroelectric power plant and submission of report and presentation.

Final Exam

The questions will cover all the chapters in the syllabus. The evaluation scheme will be as indicated in the table below:

Chapter	Hours	Marks distribution*
1	8	10
2, 5 and 6	11	15
3	16	20
4	10	15
Total	45	60

* There may be minor deviation in marks distribution.

References

1. Daugherty, R. L., Franzini, J. B., Finnemore, E. J. (2002). Fluid mechanics with engineering applications. McGraw-Hill Book Company.
2. Tritton, D. J. (2007). Physical fluid dynamics. Clarendon Press.
3. Khan, M. K. (2015). Fluid mechanics and machinery. Oxford University Press.
4. Lal, J. (2004). Hydraulic machines. Metropolitan Book Co.
5. Bansal, R. K. (2005). A textbook of fluid mechanics and hydraulic machines. Laxmi Publications.
6. Rajput, R. K. (1998). Fluid mechanics and hydraulic machines (Latest Edition). S. Chand & Company Ltd.
7. Modi, P.N., Seth, S.M. (2019). Hydraulics and fluid mechanics including hydraulic machines. Amit Publisher and Distributors.
8. Som, S. K., Biswas, G. (2010). Introduction to fluid mechanics and fluid machines. Tata McGraw-Hill Education.
9. Subramanya, K. (2005). Fluid mechanics and hydraulic machines: Problems and solutions. Tata McGraw-Hill Publishing Co. Ltd.