

# ARUNACHAL PRADESH PUBLIC SERVICE COMMISSION

## Mechanical Engineering (Conventional essay type)

### PAPER – I

Max. Marks: 200

Time: 3 Hours

Note: Answer any five full questions. All questions carry equal marks. Make suitable assumptions wherever necessary by clearly indicating the same. Draw neat diagrams wherever necessary. Programmable calculators are not allowed

- I.**
1. To produce net work in a thermodynamic cycle, a heat engine has to exchange heat with two thermal reservoirs. Explain. (04)
  2. Define COP of a refrigerator. Show that the COP of a heat pump is greater than the COP of a refrigerator by unity. (08)
  3. Establish the equivalence of Kelvin-Planck and Clausius statements. (12)
  4. What is a Carnot cycle? What are the four processes which constitute the cycle? State the Carnot's theorem. (4+8+4=16)
- II.**
1. What are the sources of heat loss in boiler plants? Give the methods used to reduce these losses. (08)
  2. Define: (i) Rankine cycle, (ii) Reheat cycle, (iii) Regenerative cycle (12)  
Draw the cycle diagrams on h-s planes.
  3. Explain the difference between:  
(i) Single acting and double acting steam engines  
(ii) Simple and compound steam engines  
(iii) Condensing and Non-condensing steam engines (12)
  4. (i) Discuss the advantages of steam turbines over steam engines  
(ii) List the advantages and limitations of velocity compounding (08)
- III.**
1. Compare C. I. engines with S. I. engines as the following points are concerned: (a) Fuel used, (b) working cycles, (c) Method of ignition, (d) Method of fuel injection (08)
  2. What are the advantages of multi-stage compression over a single stage compression for the same pressure ratio?  
Why is inter-cooling is necessary in multi-stage compression? (12)
  3. What are the disadvantages of a closed cycle gas turbine over open cycle gas turbine?  
What are the desirable properties of fluid suitable for closed cycle gas turbine operation? (12)
  4. Explain the working differences among: (i) propeller- jet, (ii) turbo-jet and (iii) turbo-prop (08)
- IV.**
1. Define the terms: (i) meta-centre, (ii) centre of buoyancy, (iii) meta-centric height, (iv) Absolute pressure (08)
  2. Differentiate between:  
(i) Steady flow and unsteady flow  
(ii) Uniform flow and Non-uniform flow  
(iii) Laminar flow and Turbulent flow  
(iv) Compressible and Incompressible flow (12)

3. State and derive an expression for Bernoulli's theorem for steady flow of an incompressible fluid from first principle and state the assumption made for such a derivation. (12)
  4. Show that the loss of head due to sudden expansion in pipe line is a function of velocity head. (08)
- V.
1. Differentiate between the turbines and pumps. (08)
  2. Obtain an expression for the work done per second by water on the runner of a Pelton wheel. Hence derive an expression for maximum efficiency of the Pelton wheel giving the relationship between the jet speed and bucket speed. (12)
  3. Define the terms:
    - (i) Specific speed of turbine
    - (ii) Unit Speed
    - (iii) Hydraulic efficiency
    - (iv) Draft tube (12)
  4. Define in case of a reciprocating pump:
    - (i) Slip
    - (ii) Percentage slip
    - (iii) Negative slip
    - (iv) Indicator diagram (08)
- VI.
1. Draw a neat diagram of vapour compression refrigeration system. Explain its working. (08)
  2. What are the required properties of an ideal refrigerant? What refrigerants are used and what factors are considered in selecting refrigerant for following purposes?
    - (a) Ice production factory
    - (b) Home refrigeration
    - (c) Big-water coolers
    - (d) Food treating and preserving rooms (4+8)
  3. Define:
    - (i) Convective heat transfer coefficient
    - (ii) Overall heat transfer coefficient
    - (iii) Counter flow heat exchange (12)
  4. State Kirchhoff's law of radiation and prove that the emissivity of a body is equal to its absorptivity under thermal equilibrium. (08)
- VII.
- Write short notes on:
- (i) Cavitation
  - (ii) Steam Nozzles
  - (iii) Boiler accessories
  - (iv) Governing of Turbines
  - (v) Air vessels (5x8=40)
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