Register No.: ……………………………… Name: ……………………………………………………………..

SAINTGITS COLLEGE OF ENGINEERING (AUTONOMOUS)

(AFFILIATED TO APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY, THIRUVANANTHAPURAM)
FOURTH SEMESTER B.TECH DEGREE EXAMINATION (Regular), JULY 2022

MECHANICAL ENGINEERING
(2020 SCHEME)

Course Code :   **20MET206**

Course Name: **Fluid Machinery**

Max. Marks :   **100**   **Duration: 3 Hours**

PART A

(Answer all questions. Each question carries 3 marks)

1. Derive the equations for efficiency of a water jet striking a semi-circular moving vane at its centre.

2. Why is the jet deflected by a bucket wheel between 160° to 170° instead of 180° in a Pelton turbine?

3. What is cavitation? List the factors affecting cavitation in hydraulic turbines.

4. How the specific speed of a pump is different from the specific speed of a turbine?

5. Distinguish between rotodynamic pump and positive displacement pump.

6. What is negative slip with reference to reciprocating pump

7. Define the following with reference to reciprocating compressors
    i)   Isothermal efficiency
    ii)   Adiabatic efficiency
    iii)   Volumetric efficiency

8. Define degree of reaction. Discuss the significance of 50% reaction blading.

9. State the assumptions made in an ideal cycle analysis of gas turbines.

10. Draw the P-V diagram and T-S diagram of Brayton cycle.

PART B

(Answer one full question from each module, each question carries 14 marks)

MODULE I

11. a) A jet of water of diameter 70 mm strikes a curved vane at its centre with a velocity of 15 m/s. The vane is moving with a velocity of 6 m/s in the direction of the jet. The jet is deflected through an angle of 165^0. Assuming the vane is smooth, find the force exerted on the vane in the direction of the jet, power and efficiency of the jet.   (5)

     b) A reaction turbine works under a head of 115 m and its speed is 450 rpm. The diameter of the inlet is 1.2 m and the flow area is 0.4 m². At the inlet, the absolute and the relative velocities make angles of 20° and 60° respectively with the   (9)

tangential velocity. Determine the power developed and the hydraulic efficiency. Assume the velocity of whirl at the outlet is zero.

<div align="center">OR</div>

12.   a)   A Pelton wheel is to be designed for a head of 60m when running at 200 r.p.m. The Pelton wheel develops 95.6475kw shaft power. The velocity of the buckets is 0.45 times the velocity of the jet, overall efficiency is 0.85 and co-efficient of the velocity is equal to 0.98   (6)

      b)   Prove that the hydraulic efficiency of a Pelton wheel turbine is maximum when the jet velocity striking the runner is twice the tangential velocity of the runner?   (8)

<div align="center">MODULE II</div>

13.   a)   A centrifugal pump lifts $2.5 m^3$/min of water to a height of 20m through a pipe line of 10cm diameter. The total length of the pipeline is 110m. Assuming an overall efficiency of 75% and an inlet loss of 0.3m, find the power required to drive the pump. Take coefficient of friction $f = 0.012$ (7)

      b)   Draw and explain the performance characteristic curves of a centrifugal pump.   (7)

<div align="center">OR</div>

14.   a)   What are draft tubes? Derive the 'Theory of draft tube'   (7)
      b)   What is 'governing of turbines'   (7)

<div align="center">MODULE III</div>

15.   a)   Prove that the area of an indicator diagram is proportional to the work done by the reciprocating pump.   (5)

      b)   A single-acting reciprocating pump has a stroke length of 15 cm. The suction pipe is 7 m long. The water level in the sump is 2.5 m below the cylinder. The diameters of the suction pipe and the plunger are 7.5 cm and 10.0 cm. If the speed of the pump is 75 rpm, determine the pressure head on the piston at the (i) beginning, (ii) middle, and (iii) end of the suction stroke. Take Darcy – Weisbach friction factor $f = 0.02$.   (9)

<div align="center">OR</div>

16.   a)   Show from first principle that the work saved, against friction in the delivery pipe of a single-acting reciprocating pump, by fitting an air vessel is 84.8%.   (8)
      b)   With a neat diagram explain the working of a jet pump   (6)

<div align="center">MODULE IV</div>

17.   a)   Draw the P-V diagram of a single acting reciprocating compressor without clearance volume and explain its working.   (8)

b)   A single stage single acting reciprocating air compressor is used to compress 7×10^{-3} m³/min of air from a pressure of 1.013 bar to 14 bar. The index of polytropic compression is 1.3 and mechanical efficiency is 82%. Determine the volumetric efficiency and power required to drive the compressor if the clearance is 3% of the swept volume.   (6)

OR

18.   With neat diagrams, explain the construction and working of the following machineries   (14)
(i)   Centrifugal compressor.
(ii)   Axial flow air compressor

MODULE V

19.   a)   A simple gas turbine cycle works with a pressure ratio of 8. The compressor and turbine inlet temperatures are 300 K and 800 K respectively. If the volume flow rate of air is 250 m³/s, compute the power output and thermal efficiency.   (10)

b)   Write the merits and demerits of a gas turbine plant over internal combustion engines.   (4)

OR

20.   a)   Draw a neat sketch and T-s diagram of a basic gas turbine plant and deduce an expression for its thermal efficiency.   (7)

b)   Differentiate between open, closed and semi closed gas turbine cycles.   (7)

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