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Reg. No. \_\_\_\_\_ Name: \_\_\_\_\_

**APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY**  
**FOURTH SEMESTER B.TECH DEGREE EXAMINATION, JUNE 2017****Course Code: ME206****Course Name: FLUID MACHINERY (ME)**

Max. Marks: 100

Duration: 3 Hours

**PART A***Answer any three questions.*

1. a. Show that the maximum efficiency of a jet striking normally on a moving flat plate in the direction of jet is  $\frac{8}{27}$  (6)  
b. The angle of deviation of a jet striking the bucket of a Pelton wheel turbine is usually less than  $180^\circ$ . Why? (4)
2. a. What is a draft tube? Why is it used in reaction turbine? What are the various types of it? (4)  
b. A jet of water moving with a velocity of 22m/s impinges on a curved vane at one end tangentially. The jet leaves vane at an angle of  $120^\circ$  to the direction of motion of the vane. The velocity of the vane is 10 m/s and the angle of the nozzle is  $20^\circ$ . Determine i) vane angle at inlet and outlet ii) Work done per kg of water. (6)
3. a. Define the following terms with reference to water turbines. Obtain the relation between them.  
i) Hydraulic efficiency ii) Mechanical efficiency iii) Overall efficiency (4)  
b. Define Type number in water turbines. What is its significance?. Derive an expression for the same. (6)
4. A Francis turbine develops 160kW at 150rpm under a head of 10m. The peripheral velocity at inlet and flow velocity at inlet of turbine are  $0.3\sqrt{2gH}$  and  $0.9\sqrt{2gH}$  respectively. The overall efficiency of the turbine is 78% and hydraulic efficiency is 82%. Draw velocity triangle and find i) guide blade angle and runner vane angle at inlet and ii) diameter and width of the runner at inlet. (10)

**PART B***Answer any three questions.*

5. a. Explain the main operating characteristics of centrifugal pumps. (4)  
b. A double acting reciprocating pump is fitted with an air vessel on suction side close to pump. The suction lift of pump is 4.5m. The length and diameter of suction pipe

- are 7.5m and 80mm respectively. The stroke of piston and its diameter both are 200mm each. Coefficient of friction is 0.01. The atmospheric head is 10.3m and separation pressure head 2.5m of water absolute. Determine i) The speed at which separation commence ii) Maximum permissible speed without air vessel. (6)
6. a. Prove from first principle that the work saved in a single acting reciprocating pump by fitting an air vessel is 84.8%. (5)
- b. The inlet and outlet diameter of impeller of a centrifugal pump are 40cm and 60cm. The velocity of flow at outlet is 2.5m/s and vane outlet angle is  $30^{\circ}$ . Find the minimum speed of the pump to start the flow. Take manometric efficiency as 75%. (5)
7. a. Explain the following:
- i) Hydraulic Accumulator ii) Vane Pump (5)
- b. Explain NPSH and Thoma's cavitation factor in centrifugal pump (5)
8. a. Explain multistaging in centrifugal pumps. Where are they used? (5)
- b. The impeller of a centrifugal pump is 1m in diameter and rotates at 1500rpm. The blades are curved backward and make an angle of  $30^{\circ}$  to the tangent at the periphery. Calculate the power required if the velocity of flow at outlet is 20m/s. Determine the head to which water can be lifted when a diffuser casing reduces the outlet velocity to 60%. (5)

### PART C

*Answer any four questions.*

9. a. How are compressors classified? List the practical applications of compressors. (4)
- b. A single stage single acting reciprocating air compressor compresses  $7 \times 10^{-3} \text{ m}^3$  of air per second from 1.0132 bar to 14 bar. The index of polytropic compression is 1.3 and mechanical efficiency 82%. If clearance is 3% of the swept volume, determine the volumetric efficiency and power required to drive the compressor and show the process on P-v diagram. (6)
10. a. What is meant by surging and choking in centrifugal compressors? (4)
- b. A three stage single acting reciprocating compressor has perfect intercooling. The pressure and temperature at the end of suction stroke in LP cylinder is 1.013 bar and  $15^{\circ} \text{ C}$  respectively. If  $8.4 \text{ m}^3$  of free air is delivered by the compressor at 70 bar per minute and work done is minimum, calculate 1) L P and I P delivery pressure 2) Ratio of cylinder volume and 3) Total indicated power, assume  $n = 1.2$  (6)
11. a. Explain the working of roots blower and obtain the expression for its efficiency. (4)

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- b. An axial flow compressor draws air at  $20^{\circ}\text{C}$  and delivers at  $50^{\circ}\text{C}$ . Assuming 50% reaction, calculate the velocity of flow if the blade velocity is  $100\text{m/s}$ , Take work factor as 0.85. Assume  $\alpha_1 = 10^{\circ}$ ,  $\beta_1 = 40^{\circ}$ . Also calculate the number of stages. (6)
12. A centrifugal compressor draws in air at temperature of  $27^{\circ}\text{C}$  running at  $18000\text{rpm}$ . The outer diameter of blade tip is  $550\text{mm}$ , slip factor is 0.82, and isentropic total head efficiency is 0.76. Calculate i) the temperature rise of air passing through the compressor ii) the static pressure ratio. Assume the velocities of air at inlet and outlet is same. Take  $C_p = 1.005\text{kJ/kgK}$ . (10)
13. a. What is meant by the term FAD in compressors? How FAD is found? (4)
- b. Obtain an expression for minimum work to be done on a two-stage reciprocating compressor with perfect intercooling. (6)
14. a. Explain the working of a screw compressor. Give their applications. (5)
- b. A single acting reciprocating air compressor with air entering at 1bar and leaving at 7bar following  $p v^{1.3} = \text{constant}$ . Free air delivered is  $5.6\text{m}^3/\text{min}$  and mean piston speed is  $150\text{m/min}$ . Take stroke to bore ratio of 1.3 and clearance volume to be  $1/5^{\text{th}}$  of swept volume per stroke. The suction temperature and pressure are atmospheric. Determine i) the volumetric efficiency ii) Speed of rotation and iii) Stroke and bore. (5)

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