Reg. No. : | | | | | | | | | | | | |

Question Paper Code : 40299

B.E./B.Tech. DEGREE EXAMINATIONS, NOVEMBER/DECEMBER 2021.

Third/Fourth Semester

CE 8394 – FLUID MECHANICS AND MACHINERY

(Common to Aeronautical Engineering/ Aerospace Engineering/Automobile Engineering/ Industrial Engineering/ Industrial Engineering and Management/ Manufacturing Engineering/Mechanical Engineering / Mechanical Engineering(Sandwich)/Mechanical and Automation Engineering/Mechatronics Engineering/Production Engineering/ Safety and Fire engineering)

(Regulations 2017)

Time : Three hours Maximum : 100 marks

Answer ALL questions.

PART A — ($10 \times 2 = 20$ marks)

1. Fluids whose rate of angular deformation is not dependant on viscosity are known as what and why?

2. A liquid compressed in a cylinder has a volume of 0.013 m^3 at 6.87×10^6 N/m^2 pressure and a volume 0.0112 m^3 at 13.73×10^6 N/m^2 pressure. What is its bulk modulus of elasticity?

3. Give any two methods of controlling boundary layer.

4. Define Equivalent pipe.

5. Manning's equation is given by $V = 1/n\ R^{2/3} S^{1/2}$, where n is the dimensionless factor. Check if the equation is dimensionally homogeneous.

6. When is dynamic similarity said to exist between prototype and model?

7. What are Rotary pumps? Give examples.

8. What is meant by slip of a pump? How is percentage slip calculated?

9. What is meant by runaway speed? Mention the ranges of runaway speed of a Pelton wheel, Francis turbine and Kaplan turbine.

10. What is the predominantly used Governor in modern turbine?

PART B — (5 × 13 = 65 marks)

11. (a) (i) What are the different types of streamline patterns for steady flow. What type of accleration is experienced in these streamline patterns? (3)

(ii) Two velocity components are given in the following cases, find the third component such that they satisfy the continuity equation. (10)

(1) $u = x^3 + y^2 + 2z^2; v = -x^2y - yz - xy$.

(2) $u = \log(y^2 + z^2);\ v = \log(x^2 + z^2)$.

Or

(b) (i) Applying Bernoulli's equation derive the expression for theoretical discharge through a venturimeter. (6)

(ii) A pipe 300 m long has a slope of 1 in 100 and tapers from 1.2 diameter at the high end to 0.6 m diameter at the low end. Quantity of water flowing is 5400 litres per minute. If the pressure at the high end is 68.67 kPa find the pressure at the low end. Neglect losses. (7)

12. (a) Derive the Darcy-Weisbach equation for head loss in pipe due to friction. (13)

Or

(b) (i) With a neat sketch illustrate Hydraulic grade line and energy grade line, for a inclined pipe connecting reservoirs. (5)

(ii) A compound piping system consists of 1800 m of 0.5 m, 1200 m of 0.40 m and 600 m of 0.3 m new cast iron pipes connected in series. Convert the system to an equivalent length of 0.4 m pipe and equivalent size pipe 3600 m long. (8)

13. (a) (i) What are the general hydraulic models? (2)

(ii) What are the limitations of distorted models? (4)

(iii) List the force ratios considered in fluid flow studies. Derive the ratios and name them. (7)

Or

(b) Show by method of dimensional analysis that the resistance R to the motion of a sphere of diameter D moving with uniform velocity V through a fluid having density ρ and viscosity μ may be expressed as $R = \left(\rho D^2 V^2\right) \Phi\left(\mu / \rho\ VD\right)$, also show that the above expression reduces to $R = k\mu\ VD$ when the motion is through viscous fluid at low velocity where k is a dimensionless constant. Find the viscosity in poise of a liquid through with a steel ball of diameter 1 mm falls with a uniform velocity of 20 mm/s. The specific gravity of the liquid is 0.91 and that of the steel is 7.8 Given $k = 3\pi$. (13)

14. (a) (i) With a neat sketch indicate the components of a reciprocating pump and explain its working. (8)

(ii) What is the role of air vessel in a reciprocating pump? (5)

Or

(b) (i) Find the power required to drive a centrifugal pump which delivers 40 litres of water per second to a height of 20 m through a 150 mm diameter and 100 m long pipeline. The overall efficiency of pump is 70% and Darcy's f = 0.06 for the pipeline. Assume inlet losses in suction pipe equal to 0.33 m. (10)

(ii) Water is to be pumped out of a deep well under a total head of 95 m. A number of identical pumps of design speed 1000 rpm and specific speed 900 rpm with a rated capacity of 150 litres/second are available. How many pumps will be needed and how should they be conned? (3)

15. (a) A pipeline 1200 m long supplies water to 3 single jet Pelton wheels. The head above the nozzle is 360 m. The velocity coefficient for the nozzle is 0.98 and coefficient of friction for the pipeline is 0.02. The turbine efficiency based on the head at the nozzle is 0.85. The specific speed of each turbine is 15.3 and head lost due to friction in the pipeline is 12 m of water. If the operating speed of each turbine is 560 rpm determine

(i) total power developed

(ii) diameter of each nozzle

(iii) diameter of the pipeline and

(iv) volume of water used per second. (13)

Or

(b) (i) Discuss the use of Draft tube and what is the efficient type used in turbines. (3)

(ii) Explain about the performance of turbine under varying working conditions. (10)

PART C — (1 × 15 = 15 marks)

16. (a) An inward flow turbine (reaction type with radial discharge) with an overall efficiency of 80% is required to develop 150 kW. The head is 8m; peripheral velocity of the wheel is 0.96 $(2gH)^{1/2}$ the radial velocity of the flow is $0.36(2gH)^{1/2}$. The wheel is to make 150 rpm and the hydraulic losses in the turbine are 22% of the available energy. Determine:

(i) the angle of the guide blade at inlet

(ii) the wheel vane angle at inlet

(iii) the diameter of the wheel

(iv) the width of the wheel at inlet.

Or

(b) A pipeline ABC 180 m long, is laid on an upward slope of 1 in 60. The length of the portion AB is 90 m and its diameter is 0.15m. At B the pipe section suddenly enlarges to 0.3 m diameter and remains so for the remainder of its length BC, 90 m. A flow of 50 litres per second is pumped into the pipe at it lower end A and is discharged at the upper end C into a closed tank. The pressure at the supply end A is 137.34kN/m². Sketch

(i) the total energy line,

(ii) the hydraulic grade line and also find the pressure at the discharge end C. Take $f = 0.02$.

———————