210 : Con. No.-JP
Con. 6284–13.

GS–6948

(3 Hours) **[Total Marks : 100**

N.B. (1) Question No. **1** is **compulsory**.
(2) Attempt any **four** out of remaining questions.
(3) Marks at **right** indicate **full** marks.

1. Attempt any four
   i. Derive Dupit's equation.
   ii. Explain water hammer with control measures.
   iii. Explain kinetic energy correction factor and Momentum Correction factor.
   iv. A projectile is travelling in air having pressure and temperature as 8.829 N/cm^2 and -2°C. If the Mach angle is 40°, find the velocity of the projectile. Take k= 1.4 and R = 287 J/kg K.
   v. Hydrodynamically rough and smooth boundary

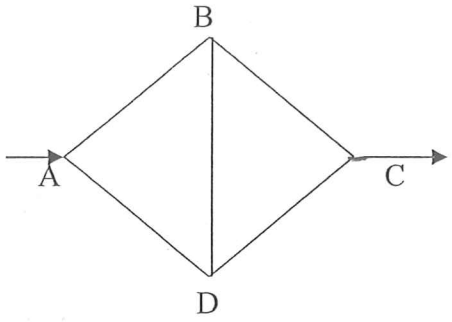
   20

2. i. Power to be transmitted hydraulically to an accumulator at a distance of 8 km by means of a number of 100 mm pipes laid horizontally, for which the coefficient of friction may be taken as 0.03. The pressure at the accumulator is maintained constant at 6524 kN/m^2. Determine the minimum number of pipes required to ensure an efficiency of at least 92% when the power delivered is 162 kW. Also determine the maximum power that can be transmitted in this case. 10

   ii. Two reservoirs have a difference of level of 5m and are connected by a pipe line which consists of a 500mm diameter pipe 3000m long feed in parallel to the lower reservoir. If coefficient of friction is 0.01 what will be the total discharge. Neglect secondary losses. 10

3. i. Two tanks A and B are connected by a pipe 30m long. The first 21m has a diameter of 75mm and then is suddenly reduced to 50mm for the next 9m. The difference of level between the tank water levels is 2.40m. The pipe coefficient is 0.005 and the contraction coefficient at sudden change in area is 0.58. Find all the losses of head in terms of the velocity, v_2 at exit from the 50mm pipe hence find the rate of flow. Draw the hydraulic gradient line. 10

   ii. Determine the discharge in each pipe of the pipe network as shown in fig below by Hardy Cross method. Take n = 1.85 10



Where K= 1 for AB and CD , K=2 for BC and AD, K= 3 for BD and Input at A is 30 units and output at C is 30 units

4. i. A reservoir A of surface level 60m above datum supplies a junction box through a 300mm pipe 1500m long. From this junction box two 300mm pipes each 1500m long feed respectively into two reservoir whose surface level are 30m and 15m above datum. Find the quantity of flow from/to each reservoir. 10

ii. Two reservoirs whose surface levels differ by 30m are connected by a pipe 600mm diameter and 3000m long. The pipe line crosses a ridge whose summit is 9m above the level of and 300m distant from the higher reservoir. Find the minimum depth below the ridge at which the pipe must be laid if the absolute pressure head in the pipe is not to fall below 2.5m of water, and calculate the discharge. Coefficient of friction = 0.0075 10

5. i. Prove the following relationship for one dimensional compressible flow 10

$$\frac{dA}{A} = \frac{dP}{\rho v^2}[1 - M^2]$$

ii. A 15 cm diameter pipelines carries discharge of 0.25 m^3/sec. Calculate the wall shear stress and height of roughness projections. N = 0.75 * 10^{-6} m^2/s, f = 0.025 10

6. i. Two parallel plates kept 0.1m apart have laminar flow of oil between them with a maximum velocity of 1.5 m/s. Calculate the discharge per meter width, the shear stress at the plates, the difference in pressure in Pascal's between two points 20m apart, the velocity gradient at the plate and velocity at 0.02m from the plate. Take viscosity of oil to be 2.453 N.s/m^2 10

ii. A missile under test is moving horizontally at Mach Number 2.0 in the atmosphere at an elevation of 305m above the earth's surface. How long does it take for an observer on the ground to hear disturbance from the instance it is directly over head? 10

Suppose an observer in a plane is moving in the same direction as the missile at a speed of sound at an elevation of 305m above missile. What is the time elapsed between the instant when the missile is directly below and the instant when the observer hears the sound? Neglect changes of speed of sound from 305m to 610m elevation. Assume air temperature be $20^{o}C$.

7. i. Derive the Prandlts universal velocity distribution equation 10

ii. Crude oil of viscosity 1.5 poise and relative density 0.9 flows through a 20 mm diameter vertical pipe. The pressure gauges fixed at two points A and B 20m apart such that point B is above point A read 600 kN/m^2. Find the direction and rate of flow through pipe. Density of fluid 900 kg/m^2. 10