

13. (a) A pipe having a length of 6 km and diameter 0.70 m connects two reservoirs A and B, the difference between their water levels is 30 m. Halfway along the pipe there is a branch through which water can be supplied to a third reservoir C. Taking friction factor as 0.024 determine the rate of flow of reservoir B when (a) no water is discharged to reservoir C; (b) the quantity of water discharged to reservoir C is $0.15 \text{ m}^3/\text{s}$. Neglect minor losses. (16)

(OR)

- (b) Derive Hagen Poiseuille equation for laminar flow through pipe line from the basic principle. (16)
14. (a) A two stage centrifugal pump is required for a fire engine for a duty of 3660 litres/min at a head of 75 m. If the overall efficiency of the pump is 75% and the specific speed per stage is about 1300, find (a) the running speed in rpm and (b) the power of the driving engine. If the actual manometric head developed is 65% of the theoretical head, there is no slip, the outlet vane angle is 30° and the radial flow velocity at exit is 0.15 times the tip speed at exit, find the diameter of the impellers. (16)

(OR)

- (b) (i) Why can the suction lift of a pump not exceed a certain limit? (4)
- (ii) A double jet Pelton wheel has a specific speed of 15 and is required to deliver 1200 kW. The turbine is supplied through a pipeline from a reservoir whose level is 420 m above the nozzles. Allowing 6% for friction loss in the pipe calculate (a) Speed in rpm; (b) diameter of jet and (c) mean diameter of bucket circle. Take $C_v = 0.98$, Speed ratio = 0.46 and over all efficiency = 85%. (12)
15. (a) (i) The cylinder bore diameter of a single acting reciprocating pump is 150mm and its stroke length is 300mm. The pump runs at 50rpm and lifts water through a height of 25m. The delivery pipe is 22m long and 100mm in diameter. Find out the theoretical discharge and theoretical power required to run the pump if the actual discharge is 4.2 litres/s. Also find the percentage slip. (8)
- (ii) Derive an expression for effect of acceleration and friction in suction and delivery pipes on indicator diagram. (8)

(OR)

- (b) (i) Determine the maximum speed at which a double acting reciprocating pump can be operated under the following conditions: (a) no air vessel on the suction side; (b) a very large air vessel on the suction side close to the pump. The suction lift is 4 m, length of suction pipe 6.5 m, diameter of suction pipe 120 mm, diameter of piston 150 mm and length of stroke is 0.45 m. Assume simple harmonic motion, atmospheric pressure head as 10.3 m for water and separation occurs at 2.6 m of water absolute. Take Darcy's $f = 0.025$. (10)
- (ii) Write short note on types of gear pumps with its application. (6)
