(13)

Scoring Indicators

1

Code : 6022(15) **Version:** D

Qn. No.	Scoring Indicators	Split score	Total score
I 1	1. rotation of turbine (Pelton wheel) 2. Reaction of jet (jet propulsion) 3. Water jet cutter	any 2 1+1	2
2	The amount of water striking the bucket of the runner is controlled by spear.	2	2
3	The water possesses kinetic energy as well as pressure energy at the inlet of the turbine is called reaction turbine	2	2
4	i liquid can be pumped from a great depth ii liquid can be delivered to a great height (iii) No moving parts, hence no prime mover is used (iv) Suitable for discharging oil	any 2 points 1+1	2
5	Net positive suction head or NPSH is defined as the difference b/w liquid pressure at pump suction and liquid vapour pressure expressed in term of height of liquid column	2	2

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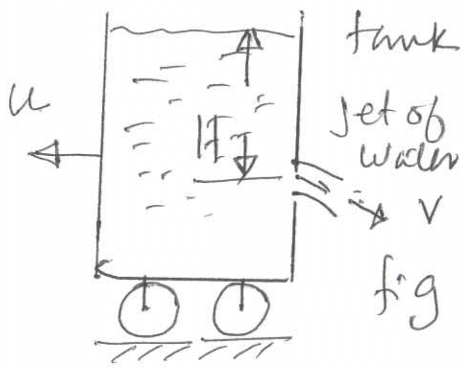
Code : **Version:**

Qn. No.	Scoring Indicators	Split score	Total score
II 1.	Jet propulsion means the propulsion of bodies such as ships, aircrafts, rockets with the help of jet. The reaction of the jet coming out from the orifice provided in the bodies is used to move the bodies.	3	
	 fig	3	6
2	$d = 75\,mm = 0.075\,m$ $a = \frac{\pi}{4}d^2 = 0.004417\,m^2$ $V = 25\,m/s \quad \theta = 60^\circ$		
	(i) $F_n = \rho a v^2 \sin\theta$ $= 1000 \times 0.004417 \times 25^2 \sin 60$ $= \underline{2390.7\,N}$	3	
	(ii) $F_x = \rho a v^2 \sin^2\theta$ $= \underline{\underline{2070.4\,N}}$	3	6

Code :

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Qn. No.	Scoring Indicators	Split score	Total score
II 3	(i) It controls the speed of the turbine (ii) It maintains the speed & frequency of the turbine to maintain a desired frequency and voltage (iii) It helps to start and shut down the turbine as required (iv) It helps to increase and decrease the opening of the nozzle & controlling discharge	1.5 mark each 1.5x4	6
II 4.	1 It is possible to establish a negative head at the outlet by an amount equal to the height of the runner outlet above the tailrace. 2. By using draft tube increasing cross section the velocity of outgoing water is reduced, this results in gain in pr. head. 3 It decreases the pressure at exit to a value less than atmosphere pr, thereby increasing the working head (~~Any 2 points~~)	~~2x3~~	~~6~~
	4. The overall efficiency of the turbine is increased by using a draft tube 5. It permits the turbine to be installed well above the tailrace without loss of head any four points (1.5x4)	1.5x4	6

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II 5	Impulse turbine	Reaction turbine		
	1. Energy utilised is KE	KE + P.E		
	2 working at atm. pr	working under pr.		
	3. The jet of water strikes the buckets	water is guided over vanes		
	4. Air tight casing not needed	Air tight casing needed		
	5. Draft tube not required	Draft tube required		
	6. components are easily accessible	Not easily accessible		
	7. All the vanes are not in action	All vanes are in action		
	8. Easy flow regulation	complicated flow regulation		
	9. working speed is less	More	Any 6	
	10 All the pr. head is converted into K. head	Only part of the available pr. head is converted into K head	6x1	6
II 6	$Q = 675\ lps = 675\times10^{-3}\ m^3/s$ $H = 13.8\ m \quad N = 700\ rpm$		2	
	specific speed $N_s = \frac{N\sqrt{Q}}{H^{3/4}}$		2	
	$= \frac{700\times\sqrt{0.675}}{(13.8)^{3/4}}$ $= \underline{80.32}$		2	6

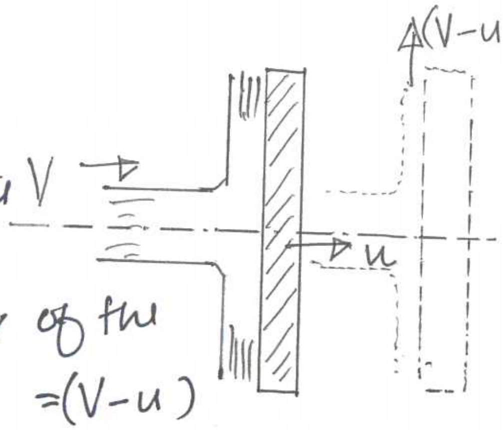
Scoring Indicators

Code : **Version:**

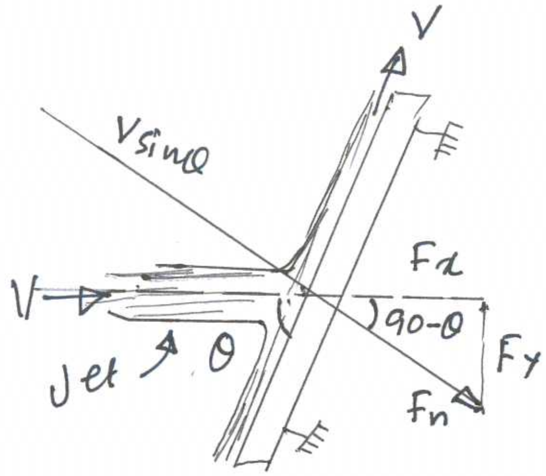
Qn. No.	Scoring Indicators	Split score	Total score
II 7.	1. According to cycle of operation (i) single acting Pump (ii) Double acting Pump 2. According to the number of cylinders (i) single cylinder (ii) Multicylinder 3. According to the position of cylinder (i) Horizontal (ii) Vertical 4. According to the pumping element (i) plunger (ii) Piston (iii) Bucket (iv) diaphram pump 5. According to arrangement of cylinder (i) single (ii) Duplex pump (iii) Triplex pump Any 4 4x1.5	1.5x4 =6	6

Scoring Indicators

Code : **Version:**

Qn. No.	Scoring Indicators	Split score	Total score
III a	V - velocity of jet a - area of jet u - velocity of plate  relative velocity of the jet w.r.to plate $= (V-u)$	fig 2	
	mass of water striking the plate/sec $= \rho a(V-u)$	2	
	$F_x = \rho a(V-u)((V-u)-0)$		
	$= \rho a(V-u)^2$	2	
	$WD = F_x \cdot u = \underline{\rho a(V-u)^2 \cdot u}$	2	8
III b	$d = 5\,cm = 0.05\,m \quad V = 15\,m/s,\ u = 5\,m/s$		
	$F = \rho a V(V-u)\,N, \ a = 0.001962\,m^2$	1	
	(i) Force on the plate $F = 1000 \times 0.001962 \times 15(V-u)$ $F = \underline{294}\,N$	2	
	work done/s $= F \cdot u = 294 \times 5$ $= 1470$ Watts	2	
	(iii) $\eta = \frac{WD}{\frac{1}{2} m V^2} = \frac{1470 \times 2}{\rho a V \cdot V^2} = \frac{1470 \times 2}{1000 \times a \times V^3}$ $= \underline{44\%}$	2	7

Code : **Version:**

Qn. No.	Scoring Indicators	Split score	Total score
IVa	θ = Angle b/w jet & plate a = area of jet V = velocity of jet 	fig-2	
	mass of water flowing/sec = $\rho a V$ Normal force $F_n = \rho a V (V\sin\theta - 0)$ $F_n = \rho a V^2 \sin\theta$	3	
	F_x - component of F_n in x direction $F_x - F_n \cos(90-\theta) = F_n \sin\theta$ $= \rho A V^2 \sin^2\theta$	3	8
IVb	$d = 2.5\,cm = 0.025\,m$, $V = 10\,m/s$ $W = 98.1\,N$ $a = \pi/4\, d^2 = 0.00049\,m^2$	2	
	angle through which the plate is swung $\sin\theta = \frac{\rho a V^2}{W} = \frac{1000 \times 0.00049 \times 10^2}{98.1}$	3	
	$\theta = 29.96$	2	7

Scoring Indicators

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Code : **Version:**

Qn. No.	Scoring Indicators	Split score	Total score
V a	1. Nozzle and flow regulating arrangement - The amt of water striking the buckets of the runner is controlled by a spear in the nozzle 2. Runner and buckets - It consist of a circular dis on the periphery of which a number of buckets evenly spaced are fixed. The shape of the buckets is of a double hemisperical cup. 3. Casing - To prevent the splashing of the water and to discharge water to tailrace 4. Breaking jet - A small nozzle is provided which directs the jet of water on the back of the vanes to stop the runner	4x2	8
V b	$n = 2,\ H = 50m,\ P = 90kW,\ \eta_o = 0.9$ $C_v = 0.96$ $\eta_o = \frac{P}{\rho g Q H}$	2	
	$\therefore Q = \frac{90}{9.81 \times 50 \times 0.9} = 0.2039\ m^3/s$		
	$V = C_v\sqrt{2gH} = 30.068\ m/s$	2	
	$Q = AV = \pi/4\, d^2 \cdot n \cdot V$		
	$\therefore d^2 = \frac{4 \times Q}{\pi \cdot n \times V}$ $\therefore d = 0.0657m$	2	
	diameter of jet $d = \underline{65.7mm}$	1	7

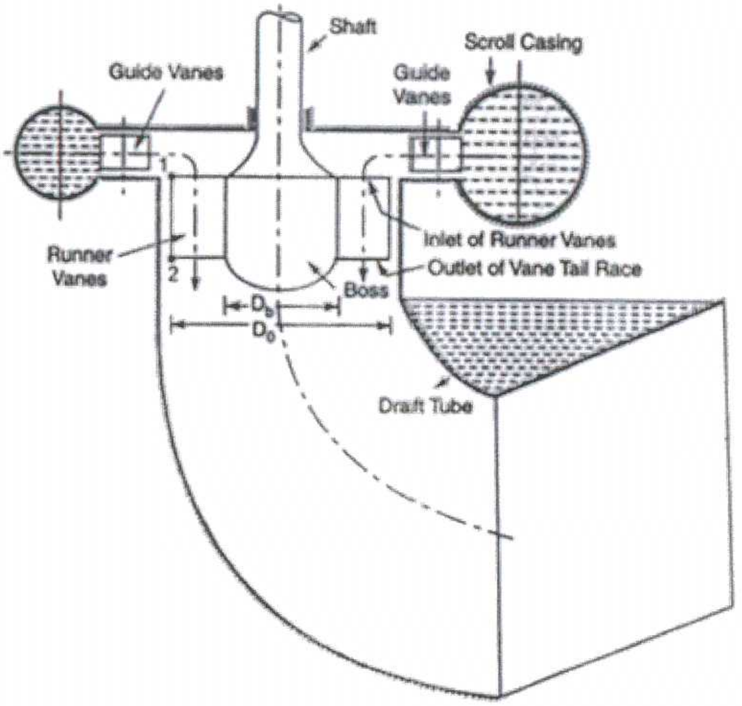
Code : **Version:**

Qn. No.	Scoring Indicators	Split score	Total score
VI a	1. According to the nature of energy possessed (i) Impulse turbine (ii) Reaction turbine 2. According to the direction of flow of water (i) tangential flow (ii) Radial flow iii) Axial flow (iv) mixed flow 3. According to the head - (i) High head turbine (ii) Medium (iii) low head 4. According to the deposition of shaft (i) Horizontal shaft (ii) vertical shaft 5. According to the name (i) Pelton wheel (2) francis turbine (iii) Kaplan turbine 6. According to the specific speed (i) low sp. speed (ii) Medium (iii) High sp. spe	Any four 4x2	8
VI (b)	$P = 3.75 \times 10^6$ Watts, Head, $H = 200m$ $Q = 2000 lps, = 2000 \times 10^{-3} m^3/s$ efficiency $\eta = \frac{P}{\rho g Q H}$ $\eta = \frac{3.75 \times 10^6}{9810 \times 2000 \times 10^{-3} \times 200}$ $= 95.57\%$	1 3 3	7

Scoring Indicators

10

Code : **Version:**

Qn. No.	Scoring Indicators	Split score	Total score
VII.a	Water from the Penstock enters the scroll casing and then moves to the guide vanes. From the guide vane the water turns through 90° and flows axially through the runner. It is a axial flow reaction turbine.	4	
	 fig	4	8
VII b	specific speed plays an important role for selecting the type of the turbine. Also the performance of a turbine can be predicted by knowing the sp. speed of the turbine	3	
	specific speed — Type of turbine 1. 8.5 to 30 — pelton wheel with single jet 2 30 to ~~60~~ 51 — Pelton wheel with 2 or more jet 3 ~~60~~ 51 to ~~300~~ 225 — Francis turbine 4 255 to 860 — Kaplan ~~ox~~	4	7

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Qn. No.	Scoring Indicators	Split score	Total score
VIII a	specific speed of a turbine is defined as the speed at which a turbine runs when it is working under a unit head and develop unit power $N_s = N\sqrt{P}/H^{5/4}$	2	
	Unit speed - speed of a turbine working under a unit head $N_u = N/\sqrt{H}$	2	
	Unit discharge - discharge passing through a turbine which is working under a unit head $Q_u = Q/\sqrt{H}$	2	
	Unit power - power developed by a turbine working under a unit head. $P_u = P/H^{3/2}$	2	8
VIII b	$H = 56\,m$, $SP = 10\times10^6\,W$, $D_h = 0.35\,D_o$, speed ration $\rho = 2.1$ $\psi = 0.67$ $\eta_o = 0.85$		
	Velocity of runner $u = \rho\sqrt{2gH} = 2.1\times\sqrt{2gH} = 69.6\,m/s$		
	flow velocity $V_f = \psi\sqrt{2gH} = 22.2\,m/s$	1	
	$\eta_o = \frac{SP}{wQH} = \frac{10\times10^6}{9810\times Q\times56}$, $Q = 21.4\,m^3/s$	2	
	$Q = \frac{\pi(D_o^2 - D_h^2)}{4}V_f$ $D_h = 0.35D_o$	2	
	$D_o = 1.37\,m$, $D_h = 0.48\,m$, $D = \frac{D_o + D_h}{2}$		
	Diameter of runner = 0.925 m		
	$u = \frac{\pi ND}{60}$ $\therefore N = \frac{u\times60}{\pi\times D}$ =	2	7
	= 1437 rpm		

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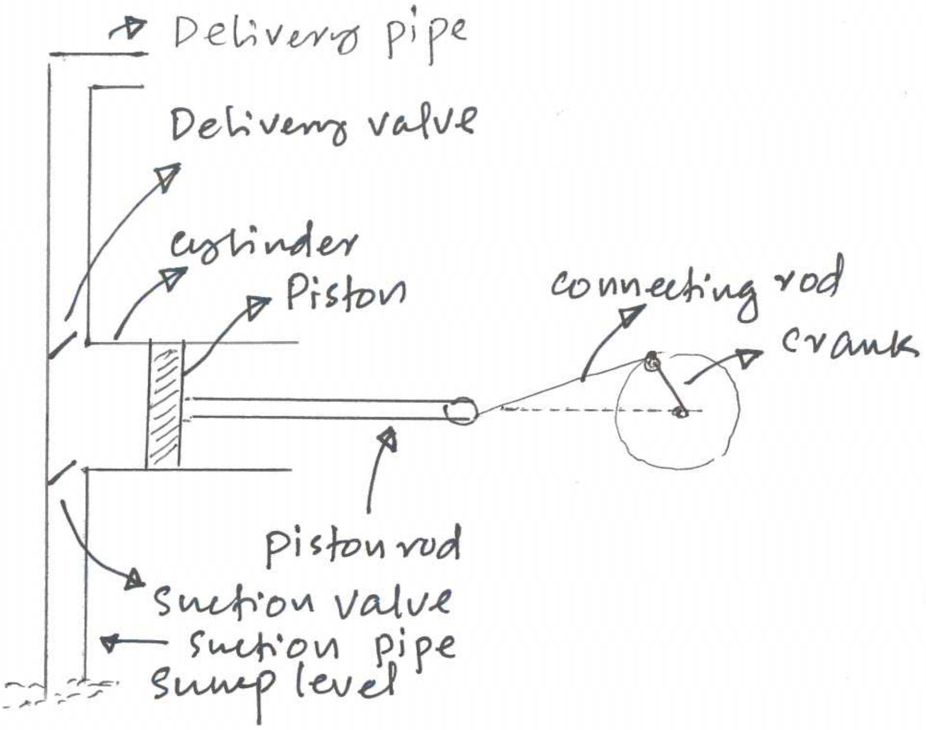
IX a	 fig	4	
	1. A cylinder, piston, piston rod, con. rod, crank 2 suction & delivery pipe 3 Suction & delivery valve (Description	4	8
IX b	Cavitation is defined as a phenomenon of formation of vapour bubbles in a region where the pr. of the liquid falls below its vapour pr. and sudden collapsing of these vapour bubbles in a region of higher pr. Cavitation may occur at the inlet of the impeller of the pump or at the suction side. It can be noted by sudden drop in efficiency & head.	3.5	
	Priming is the process of filling the impeller casing and the suction pipe before starting the pump with the liquid to be pumped inorder to remove any air, or vapour from the liquid way	3.5	7

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Qn. No.	Scoring Indicators	Split score	Total score
X a	Volute casing - This is a spiral shaped whose area of cross section gradually increases towards the delivery pipe. The velocity decreases as area increases along the path of flow. This arrangement converts KE into Pr. energy. The efficiency of this casing is less than others. Large amt of energy is lost due to formation of eddies.	4	
	Vortex casing – A circular chamber is introduced between impeller & casing. Liquid from the impeller enters into the vortex chamber then through the volute chamber. Eddy loss is considerably reduced, efficiency is increased as compared with volute casing	4	8
X b	$N = 60$, $Q = 0.0335\ m^3/s$, $L = 0.35\ m$ $d = 0.25\ m$, $A = \frac{\pi}{4} d^2 = 0.049\ m^2$ $h_s = 4.5\ m$, $h_d = 18\ m$	1	
	$Q_{th} = \frac{2LAN}{60} = 0.0343\ m^3/s$	2	
	$\%$ of Slip $= \frac{Q_{th} - Q_a}{Q_{th}} = 0.023$ $= 2.3\%$ Ans	2	
	Power $= \rho g Q_{th} (h_s + h_d)$ $= 1000 \times 9.81 \times 0.0343 \times 22.5$ $= 7570$ Watts or 7.5 KW Ans	2	7