Scheme of Valuation/Answer Key

(Scheme of evaluation (marks in brackets) and answers of problems/key)

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

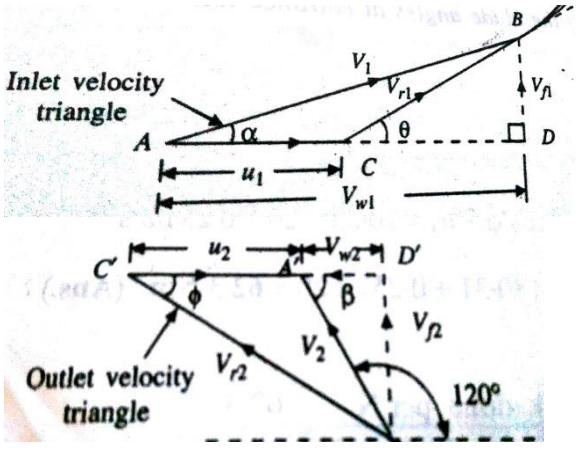
FOURTH SEMESTER B.TECH DEGREE EXAMINATION, APRIL 2019

Course Code: CE206

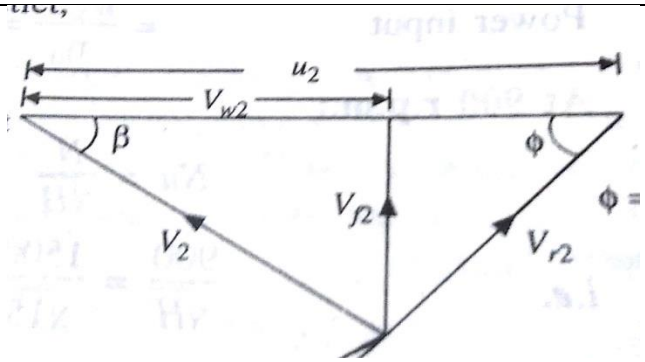
Course Name: FLUID MECHANICS II (CE)

Max. Marks: 100		Duration: 3 Hours

PART A

		Answer any two full questions, each carries 15 marks.	Marks
1	a)	output – 1 mark, efficiency – 1 mark, Condition for maximum efficiency-2 marks, maximum efficiency- 1 mark	(5)
	b)	$K_u = 2$, H =30 m, $\Psi = 0.65$, d = 0.35D, $\eta_0 = 0.9$, P = 15000 kW $u_1 = K_u\sqrt{2gH}$ = 48.52 m/s ……1 mark $V_{f1} = \psi\sqrt{2gH}$ = 15.77 m/s……1 mark P = γ Q H η_0. Hence Q = 56.63 m^3/s……2 marks But Q = $\frac{\pi}{4}(D^2 - d^2) V_{f1}$. Solving D = 2.283 m……1 mark $u_1 = \frac{\pi DN}{60}$. Hence N = 406 rpm……2 marks	(7)
	c)	Explanation - 3 marks	(3)
2	a)	 Inlet and outlet velocity triangle….. 1 mark V_1 = 35 m/s, $u_1 = u_2 = u$ = 20 m/s, $\alpha = 30^0$ $\beta = 180 - 120 = 60^0$	(10)

		$V_{w1} = V_1 \cos\alpha = 30.31$ m/s $V_{f1} = V_1 \sin\alpha = 17.50$ m/s $\tan\theta = \frac{V_{f1}}{V_{w1}-u}$, gives $\theta = 59.5^0$ ….2 marks using sine rule, from inlet velocity triangle, $\frac{V_{r1}}{\text{Sin } 90} = \frac{V_{f1}}{\text{Sin } \theta}$, gives $V_{r1} = 20.31$ m/s ….1 mark $V_{r2} = V_{r1} = 20.31$ m/s Appling sine rule to outlet velocity triangle, $\frac{V_{r2}}{\text{Sin } 120} = \frac{u}{\text{Sin } (60-\phi)}$,gives $\phi = 1.48^0$ ….2 marks $V_{w2} = V_{r2} \cos\phi - u = 0.30$ m/s Work done per unit weight = $\frac{1}{g}(V_{w1} + V_{w2})u = 62.4$ m….2 marks Energy supplied per unit weight = $\frac{V_1^2}{2g}$….. 1 mark $\eta = \frac{\text{Work done per unit weight}}{\text{Energy supplied per unit weight}} = 99.9$ % ….. 1 mark	
	b)	H = 500 m, N = 420 rpm, d =18 cm, $C_v = 0.98$, $\eta_o = 0.85$ $V_1 = C_v\sqrt{2gH} = 97.06$ m/s ….1 mark $Q = \frac{\pi}{4} d^2 V_1 = 2.47$ m^3/s….1 mark $P = \gamma Q H \eta_0 = 10292$ kW….1 mark $N_s = \frac{N\sqrt{P}}{H^{5/4}} = 18$ ….2 marks	(5)
3	a)	Derivation of specific speed, $N_s = \frac{N\sqrt{Q}}{H_m^{3/4}}$ ….. 5 marks	(5)
	b)	Q = 0.2 m^3/s, H = 25 m, N = 1400 rpm, $\eta_m = 0.8$, $D_2 = 0.3$ m, $B_2 = 0.05$ m $u_2 = \frac{\pi D_2 N}{60} = 22$ m/s,……1 mark $\eta_m = \frac{gH}{u_2 V_{w2}}$, gives $V_{w2} = 13.94$ m/s,……2 marks $Q = \pi D_2 B_2 V_{f2}$, gives $V_{f2} = 4.244$ m/s,……1 mark	(7)

		 From outlet velocity triangle,……1 mark tan $\phi = \frac{V_{f2}}{u_2 - V_{w2}}$, gives ϕ = 27. 77^0…….2 marks	
	c)	Definition of net positive suction head ….3 marks	(3)
PART B			
Answer any two full questions, each carries 15 marks.			
4	a)	i) wetted Perimeter- 1 mark ii) Hydraulic depth – 2 marks and iii) Hydraulic radius – 2 marks	(5)
	b)	Q = 150 m^3/s, S = $\frac{1}{1000}$, C = 50, z = 1……1 mark B + 2zy = $2y\sqrt{z^2+1}$ = 0.82y……2 marks A = (B + zy)y = $1.82y^2$……2 marks R = 0.5 y……1 mark Q = AC $\sqrt{RS}$ ……2 marks, gives y = 5.585 m……1 mark and B = 4.58 m……1 mark	(10)
5	a)	Derivation – 7 marks	(7)
	b)	F_1 = 10, E_L= 4 m $\frac{y_2}{y_1} = \frac{1}{2}[-1 + \sqrt{1 + 8{F_1}^2}]$ = 13.65 m ……1 mark $E_L = \frac{(y_2 - y_1)^3}{4y_1y_2}$ ……1 mark $\frac{E_L}{y_1} = \frac{(\frac{y_2}{y_1} - 1)^3}{4\frac{y_2}{y_1}}$, gives y_1 = 0.108 m……1 mark and y_2 = 1.47 m……1 mark $F_1 = \frac{V_1}{\sqrt{gy_1}}$, gives V_1 = 10.3 m/s……1 mark q = V_1y_1= 1.11 m^3/s/m……1 mark	(8)

		$q = V_2 y_2$, gives V_2 = 0.755 m/s……1 mark $F_2 = \frac{V_2}{\sqrt{g y_2}}$ = 0.2……1 mark	
6	a)	i) conveyance of a channel section – 3 marks ii) normal depth -2 marks	(5)
	b)	Q = 1.8 m^3/s, y_1 = 0.2 m, B = 1.8 m $A_1 = B y_1 = 0.36\ m^2$……1 mark $V_1 = \frac{Q}{A_1}$ = 5 m/s ……1 mark $E_1 = y_1 + \frac{V_1^2}{2g}$ = 1.472 m……1 mark $E_2 = y_2 + \frac{V_2^2}{2g}$ = 1.472 , $V_2 = \frac{Q}{A_2}$, $A_2 = B y_2$ Substituting and solving by trial and error, y_2 = 1.45 m……3 marks $F_1 = \frac{V_1}{\sqrt{g y_1}}$ = 3.57……1.5 marks $V_2 = \frac{Q}{A_2}$ = 0.69 m/s……1 mark $F_2 = \frac{V_2}{\sqrt{g y_2}}$ = 0.1829……1.5 marks	(10)
		PART C	
		Answer any two full questions, each carries 20 marks.	
7	a)	Six assumptions- 3 marks, Derivation -5 marks	(8)
	b)	Q = 10 m^3/s, B = 6 m, S = 0.0016 , n = 0.025, z = 2 $Q = \frac{1}{n} A R^{2/3} S^{1/2}$……1 mark $10 = \frac{(6+2y_n)y_n}{0.025} \left[\frac{(6+2y_n)y_n}{B+2\sqrt{5}y_n}\right]^{2/3} \sqrt{0.0016}$……2 marks Solving by trial and error, y_n = 0.96 m……2 marks $\frac{Q^2}{g} = \left(\frac{A^3}{T}\right)_c$……1 mark $A = (6 + 2y_c)y_c$ and $T = 6 + 4y_c$……2 marks Solving by trial and error, y_c = 0.61 m……2 marks As $y_n > y_c$, the channel is mild slope……1 mark y = 2.96 m $> y_n > y_c$, water profile is M_1 type……1 mark	(12)
8	a)	f (F, ρ, L, V, g, μ) = 0	(10)

		Dimensions of parameters: F = MLT^{-2}, $\rho = ML^{-3}$, L = L, V= LT^{-2}, $\mu = ML^{-1}T^{-1}$, g = LT^{-2}……1 mark n = 6, m = 3. No of π terms = n-m = 3……1 mark let ρ, L, V be the repeating variables……1 mark $\pi_1 = \rho^{a1}L^{b1}V^{c1}\mu$ $\pi_2 = \rho^{a2}L^{b2}V^{c2}g$ $\pi_3 = \rho^{a3}L^{b3}V^{c3}F$ Equating the power of dimensions on both sides and solving, $\pi_1 = \frac{\mu}{\rho LV}$……2 marks $\pi_2 = \frac{Lg}{V^2}$……2 marks $\pi_3 = \frac{F}{\rho L^2V^2}$……2 marks $\frac{F}{\rho L^2V^2} = f\left(\frac{\mu}{\rho LV}, \frac{Lg}{V^2}\right)$ ……1 mark	
	b)	Three similarities, 2 marks each	(6)
	c)	Froude model law with equation – 4 marks	(4)
9	a)	Q = 25 m^3/s, $S_o = \frac{1}{5000}$, C = 55, B = 20 m, y = 3m $\frac{dy}{dx} = \frac{S_o - S_f}{1 - F^2}$ …. 2 marks A = 20 x 3 = 60 m^2, P = 20 +2 x 3 = 26 m…. 1 mark R = $\frac{A}{P}$ = 2.31 m, V = $\frac{Q}{A}$ = 0.416 m^2…. 1 mark $S_f = \frac{V^2}{RC^2}$ = 2. 48 x 10^{-5}…. 2 marks F = $\frac{V}{\sqrt{gy}}$ …. 1 mark $\frac{dy}{dx}$ = 0.0001764…. 2 marks As $\frac{dy}{dx} < S_o$, water surface will rise. …. 1 mark	(10)

	b)	$\frac{\rho_r L_r V_r}{\mu_r} = 1$ …. 1 mark $L_r = 5$, $\rho_r = \mu_r = 1$, $V_r = L_r$, $V_p = 75$ km/h, gives $V_m = 375$ km/h…. 1 mark Force ratio = $\rho_r L_r^2 V_r^2 = L_r$…. 2 marks $F_m = 300$ N, $F_p = \frac{F_m}{5} = 60$ N…. 1 mark Power of prototype = $F_p V_p = 1562.5$ watts…. 2 marks	(7)
	c)	backwater curve and drawdown curve – 1.5 marks each	(3)
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