**APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY**

FOURTH SEMESTER B.TECH DEGREE EXAMINATION, MAY 2017

**Course Code: CE206**

**Course Name: FLUID MECHANICS -II.**

Max. Marks: 100 Duration: 3 Hours

Scheme of evaluation

## PART A

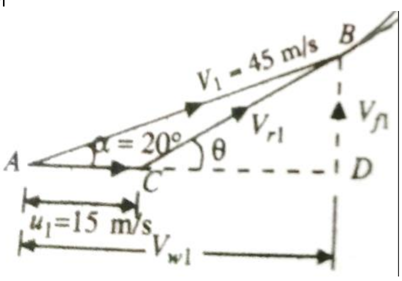
**1.** a) Maximum efficiency, $\eta_{hmax} = 0.5(1+k\cos\phi)$ .

where, k = relative velocity at outlet/relative velocity at inlet

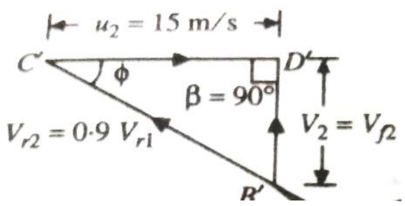
$\phi$ = vane angle at outlet

Derivation with sketch of velocity triangles for pelton wheel -5marks

b)




Inlet velocity Triangle




Outlet Velocity Triangle

Velocity Triangles- 1mark

$\tan\theta = \frac{V_{f1}}{V_{w1} - u_1}$

$V_{f1} = V_1 \sin\alpha = 15.39$ m/s

$V_{w1} = V_1 \cos\alpha = 42.29$ m/s

$V_1 = 45$ m/s, $\alpha = 20^0$

Substituting, $\theta = 29.42^0$ …2.5 marks

$\sin\theta = \frac{V_{f1}}{V_{r1}}$, $V_{r1} = 31.33$ m/s

$V_{r2} = 0.9\, V_{r1} = 28.2$ m/s

$\cos\phi = \frac{u_2}{V_{r2}}$, $\phi = 57.87^0$ … 2.5 marks

Work done on vanes per unit weight of water = $\frac{V_{w1}u_1}{g}$ = 64.66 m …2 marks

Kinetic head supplied by the jet = $\frac{V_1{}^2}{2g}$ = 103.22 m …1 mark

$\eta_h$ = Work done per unit weight / Kinetic head = 62.65 %. ... 1 mark.

**2.** a) Figure- 2 marks, explanation – 3marks.

b) $\frac{p_2}{\omega}$ = -[$H_s$ +($\frac{V_2^2}{2g} - \frac{V_3^2}{2g}$)] …1 mark

$\frac{p_2}{\omega}$ = - 5m & $H_s$ = 1.6 m,

Substituting,

$\frac{V_2^2}{2g} - \frac{V_3^2}{2g}$ = 3.4 m … 2 marks

$\eta_d$ = ($\frac{V_2^2}{2g} - \frac{V_3^2}{2g}$)/ $\frac{V_2^2}{2g}$ …1 mark

$\eta_d$ = 0.78

Substituting,

$V_2$ = 9.25 m/s …2marks

Q = $A_2V_2$ … 1 mark

$D_1$ = 3 m

$A_2 = \frac{\pi}{4} D_1{}^2 = 28.26\ m^2$

Q = 65.38 $m^3$/s …1 mark

P = 3000 kW, H = 5 m

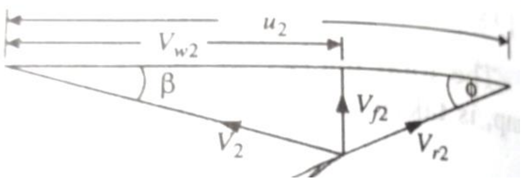
$\eta_o = \frac{P}{\omega QH}$ = 93.55% …2 marks



**3.** a) i.Specific speed of centrifugal pump – 2.5 marks

ii.Net Positive Suction Head. - 2.5marks

b)




Outlet velocity triangle – 1 mark

$D_1$= 0.36 m, $D_2$ = 0.72 m, $V_{f2}$= 2.4 m/s, $\phi = 45^0$, $\eta_{mano}$ = 70%

$\tan \phi = \frac{V_{f2}}{u_2 - V_{w2}}$ …1 mark

$V_{w2} = u_2 - 2.4$

$u_2 = \frac{\pi D_2 N}{60} = 0.0377\ N$

$V_{w2}$ = 0.0377 N – 2.4 … 2 marks

$\frac{1}{2g}[\left(\frac{\pi D_2 N}{60}\right)\left(\frac{\pi D_2 N}{60}\right) - \left(\frac{\pi D_1 N}{60}\right)\left(\frac{\pi D_1 N}{60}\right)] = H_{mano}$ … 2 marks

$\eta_{mano} = \frac{gH_{mano}}{V_{w2}u_2}$ …1 mark

$H_{mano} = \eta_{mano}\frac{V_{w2}u_2}{g}$ & $u_2 = \frac{\pi D_2 N}{60}$

Substituting and simplifying

$\frac{\pi N}{120}(D_2{}^2 - D_1{}^2) = \eta_{mano} V_{w2} D_2$ ….2 marks

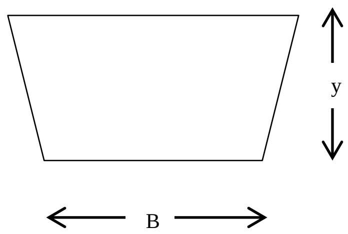
N = 137.2 rpm ….1 mark

**PART B**

**4.** a) i. Gradually varied flow and rapidly varied flow -3marks

ii. subcritical and supercritical flow - 3marks

b) For efficient channel section,




$R = \frac{y}{2}$, …1 mark

$B + 2zy = 2y\sqrt{z^2 + 1}$ …1 mark

Sideslope, z = 2

B = 0.4721 y …1 mark

$A = (B + zy)y = 2.4721\ y^2$ …1 mark

$Q = 15\ m^3/s$

n = 0.014

$S = \frac{1}{5000}$

$Q = \frac{1}{n} AR^{2/3}s^{1/2}$ …. 2 marks

Substituting and solving, y = 2.329 m ….2 marks

B = 1.1 m …1 mark

**5.** a) let $y_n$ = normal depth , B = 3.5 m

$A = 3.5\ y_n$ …1 mark

$P = 3.5 + 2\ y_n$ …1 mark

$R = \frac{3.5\ y_n}{3.5 + 2y_n}$ …1 mark

$Q = \frac{1}{n} AR^{2/3}s^{1/2}$ …1 mark

$Q = 5\ m^3/s$, S =0.0005, n = 0.02

Substituting and solution by trial and error …2 marks, $y_n = 1.48$ m …1mark

b) critical depth $y_c = 1.2$ m, B = 3 m, n = 0.014

$y_c = (\frac{q^2}{g})^{1/3}$…1 mark

$q = 4.12\ m^3/s/m$ …1 mark

$Q = qB = 12.35\ m^3/s$ …1 mark

$A = By = 3.6\ m^2$ …1 mark

P = B + 2y = 5.4 m ….1 mark

$R = \frac{A}{P} = 0.6667$ m …1 mark

$Q = \frac{1}{n} AR^{2/3}s^{1/2}$ …. 1 mark

$S = 3.96 \times 10^{-3}$ ….1 mark

**6.** a) Alternate depths – 2.5 marks

Conjugate depths – 2.5 marks

b) $y_1 = 0.2$ m, $F_1 = 9$

$\frac{y_2}{y_1} = \frac{1}{2}\left(-1 + \sqrt{1 + 8F_1^{\ 2}}\right)$ …1 mark

$y_2 = 2.45$ m …1 mark

Energy loss, $E_L = \frac{(y_2 - y_1)^3}{4y_1y_2} = 5.81$ m …2 marks

$F_1 = \frac{V_1}{\sqrt{gy_1}}$ ….1 mark

$V_1 = 12.6$ m/s …1 mark

$E_1 = y_1 + \frac{{V_1}^2}{2g} = 8.29$ m ….2 marks

$E_L = E_1 - E_2$ …1 mark

$E_2 = 2.48$ m ….1 mark

**PART C**

**7.** a) Sketch of $S_1$, $S_2$ and $S_3$ profiles – 7 marks

b) B = 12 m, y = 3.6 m, V = 1.2 m/s, $S_o = \frac{1}{4000}$ , $S_e = 0.00004$

$\frac{dy}{dx} = \frac{S_o - S_e}{1 - \frac{V^2}{gy}}$ ….3 marks

Substitution ….3 marks

$\frac{dy}{dx} = 0.0002189$ …2 marks

c) Backwater curve -2.5 marks

Drawdown curve -2.5 marks

**8.** a) F = f (L,V, μ, ρ, K )

n = 6, m = 3

No of π terms = n – m = 3….0.5 mark

Dimensions of terms,

$F = MLT^{-2}$, $L = L$, $V = LT^{-1}$, $\mu = ML^{-1}T^{-1}$, $\rho = ML^{-3}$, $K = ML^{-1}T^{-2}$

$\pi_1 = L^{a1}. V^{b1}. \rho^{c1}. F$

$\pi_2 = L^{a2}. V^{b2}. \rho^{c2}. \mu$

$\pi_3 = L^{a3}. V^{b3}. \rho^{c3}. K$ ….0.5 mark

Substituting dimensions amd simplifying,

$\pi_1 = \frac{F}{L^2V^2\rho}$ ….2 marks

$\pi_2 = \frac{\mu}{LV\rho}$ ….2 marks

$\pi_3 = \frac{K}{V^2\rho}$ ….2 marks

$F = L^2V^2\rho\ \phi\ [\frac{F}{L^2V^2\rho} , \frac{K}{V^2\rho}]$ ….1 mark

b) B = 1.5 m, $y_n = 1$ m, S = 0.0006, n = 0.012

$A = B\ y_n = 1.5\ m^2$

$P = B + 2y_n = 3.5$ m

$R = \frac{A}{P} = 0.4286$ m ….1 mark

$Q = \frac{1}{n} AR^{2/3}s^{1/2}$ …1 mark

$Q = 1.74\ m^3/s$

$q = \frac{Q}{b} = 1.16\ m^3/s/m$ ….1 mark

$y_c = (\frac{q^2}{g})^{1/3}$ ….1 mark

$y_c$ = 0.516 m ….1 mark

$y_1$ = 0.92 m, $A_1 = By_1$ = 1.38 $m^2$, $P_1 = B + 2y_1$ = 3.34 m

$R_1 = \frac{A_1}{P_1}$ = 0.413 m. ….1 mark

$V_1 = \frac{Q}{A_1}$ = 1.26 m/s

$E_1 = y_1 + \frac{V_1^2}{2g}$ = 1 m ….1 mark

$y_2$ = 0.86 m, $A_2 = By_2$ = 1.29 $m^2$, $P_2 = B + 2y_2$ = 3.22 m, $R_2 = \frac{A_2}{P_2}$ = 0.40 m.

$V_2 = \frac{Q}{A_2}$ = 1.35 m/s

$E_2 = y_2 + \frac{V_2^2}{2g}$ = 0.953 m ….1 mark

$S_{f1} = \frac{V_1^2 n^2}{R_1^{4/3}}$ = 7.432 x $10^{-4}$ ….1 mark

$S_{f2} = \frac{V_2^2 n^2}{R_2^{4/3}}$ = 8.904 x $10^{-4}$ ….1 mark

$S_f = \frac{S_{f1}+S_{f2}}{2}$ = 8.168 x $10^{-4}$

$\Delta x = \frac{E_2 - E_1}{S - S_f}$ = 217 m ….2 marks

**9.** a) Geometric similarity – 1.5 marks
Kinematic similarity – 1.5 marks
Dynamic similarity – 2 marks

b) Froude model law – 2.5 marks
Reynolds model law – 2.5 marks

c) $L_r = \frac{L_p}{L_m}$ = 25

$V_m$ = 1.65 m/s, $F_m$ = 3.92 N, $H_m$ = 3.5 cm

Froude model law, $\frac{V_r}{\sqrt{g_r L_r}}$ = 1 …2 mark

$g_r$ =1, $V_r$ = 5

$V_r = \frac{V_p}{V_m}$, $V_p$ = 8.25 m/s …1 marks

$F_r = \rho_r L_r^2 V_r^2$ …1 mark

$\rho_r$ = 1, $F_r = L_r^3$

$F_r = \frac{F_p}{F_m}$, $F_p$ = 61.25 kN …2 marks

$\frac{H_p}{H_m} = L_r$ …1 mark

$H_p$ = 87.5 cm ….1 mark

$F_p = \frac{1}{2} (C_D)_p \rho_p A_p V_p^2$ ….1 mark

$\rho_p$ = 1000 kg/$m^3$, $A_p$ = 1.5 x 3 = 4.5 $m^2$

$(C_D)_p$ = 0.4 …1mark