DEDAN KIMATHI UNIVERSITY OF TECHNOLOGY
UNIVERSITY EXAMINATIONS 2020/2021 ACADEMIC YEAR

FOURTH YEAR SECOND SEMESTER EXAMINATIONS FOR THE DEGREE OF BACHELOR OF EDUCATION TECHNOLOGY IN CIVIL ENGINEERING

UNIT CODE: ECE 3212

UNIT TITLE: HYDRAULICS II

DATE: 28TH SEPETEMBER **TIME: 2:00-4:00PM**

INSTRUCTIONS TO CANDIDATES

- This paper contains FOUR (4) questions
- Answer any THREE (3) questions
- All questions has equal total marks
- All symbols have their usual meaning unless otherwise stated

This paper consists of 4 printed pages. Please turn over.

QUESTION ONE [30marks]

a. The impeller of a centrifugal pump has a diameter of 0.15m and an axial width at the outlet of 16mm. There are 16 blades shaped backwards and inclined at 25° to the tangent of the periphery. The flow rate through the impeller is 9m3/hr when it rotates at 750 revolutions per minute. Calculate the head developed by the pump when handling water and assuming one dimensional ideal flow theory and allowing for relative eddy between the blades determine the actual head developed. [13 marks]

b. Discuss the phenomenon of slip in hydraulic machines.

[5 marks]

c. A wave in water 100 m deep has a period of 10 s and a height of 2m. Determine the wave celerity, length, and steepness.

i. What is the water particle speed at the wave crest?

11. when it has propagated into a near shore depth of 2.3 m. Calculate the wave celerity and length

[9 marks]

d. With examples list the two main classes of turbines

[3 marks]

QUESTION TWO [30 marks]

a. A Kaplan turbine delivering 40MW works under a head of 35m and runs at 167rpm. The hub diameter is 2.5m and runner tip diameter is 5m. The overall efficiency is 87%. Determine:

i) The blade angles at the hub and tip and at a diameter of 3.75m.

ii) The speed ratio and flow ratio based on the tip velocity. Assume 1JH 9=0%

[22 marks]

b. A single acting reciprocating pump has a plunger of dia. 300mm and stroke of 200mm. if the speed of the pump is 30rpm and it delivers 6.5l/s of water. Find the coefficient of discharge and the percentage of slip of the pump.

[4 marks]

c. Based on the method by which mechanical energy is transferred to the fluid with examples elaborate on the two main classes of pump classification.

[4 marks]

QUESTION THREE [30 marks]

a. A Pelton turbine is required to develop 9000kW when working under a head of 300m. The impeller may rotate at 500rpm. Assuming a jet ratio of 10 and overall efficiency of 85%, calculate the following assuming a speed parameter of 0.48:

i. Quantity of water required.
11. Diameter of wheel
iii. Number of jets
iv. Number and size of bucket vanes on the runner
v. The velocity triangles at inlet and outlet

[15marks]

b. A Francis Turbine delivers 16MW with an overall efficiency of 85% and a hydraulic efficiency of 91 % when running at 350rpm under a head of 1OOm. Assume Internal Diameter is 0.6 of outer diameter and the width is 0.1 of the diameters. The flow ratio is 0.2 and blade blockage is 8% of flow area at the inlet. AssU171e constant flow velocity and zero whirl at exit. Determine the runner diameter and blade angles.

. [15marks]

QUESTION FOUR [30 marks]

a. The inlet of a draft tube of a reaction turbine is 2.5m above the tail race level. The outlet area is 3times the inlet area. Velocity at inlet is 8m/s. kinetic head recovery is 80%. Considering atmospheric head as 1Om water column, determine the pressure at the draft tube inlet.
[7marks]

b. List the function of a draft tube **[3 marks]**

c. A centrifugal pump is required to produce a flow of water at a rate of $0.0160m^3/s$ against a total head of 30.5m. The operating characteristics of a pump at a speed of 1430rpm and a rotor diameter of 125mm is as follows:

Efficiency	0	48	66	66	45	%
UA	0	0.0148	0.0295	0.0441	0.059	M^3/s
HA	68.6	72	68.6	53.4	22.8	M

Determine:

i. Correct size of pump and its speed to produce the required head and flow.
ii. If only the 125mm pump is_available, what speed must it run to obtain the required head and flow.
iii. What is the efficiency and input power to the pump?

[20 marks]

Formula sheet

$$p \quad \frac{4 \cdot f \cdot l}{g \cdot V'} \quad \frac{c^2}{d_n} \quad \frac{\cdot -}{21\{} \quad \overline{V} \quad = \quad \backslash V + U$$

Stodda's

$$S_F = 1 \quad 2 \; [1 - (\frac{n \sin\{J_2}{)\cot\{J} \;]^2$$

$$W_{shaft} = \frac{V_2^2 - V_1^2}{2} + \frac{U_2^2 - U_1^2}{2} - \frac{(\backslash ½^2 - vV1^2)}{2}$$

T = pQ(r, -:, ₁ ,] -v,.? r2)__

$$pO \; (V.\, u_1 - V_{,.,.}\, u_2)$$

$$pg\Theta \quad \frac{1}{g}(V_{..,|}\, u_1 - V_{ıv.,}\, u_2)$$

p Q($_{V2}$ 72 — ’1 r1)

$V_{w_2} = u_2 - V_{J_2} \cot (Jr - /3)$

$$\tan a = \frac{V_{f1}}{U_1} = \frac{C_{0t}}{U_1} \quad U_1 = \frac{1rD_1 N}{60} \quad \text{and} \quad V_i = V_{f1} = \frac{Q}{1rD_1 B_1}$$

$$W = \frac{8\phi}{0Z} = O \text{ at } z = -d$$

$$v_2^2 = V_{1\phi 2}^2 + V_{j2}^2$$

	$NPSH = \frac{P_s}{\gamma} + \frac{V^2}{2g} - \frac{P_v}{\gamma}$	
	$\frac{\partial^2 \phi}{\partial x^2} + \frac{\partial^2 \phi}{\partial y^2} + \frac{\partial^2 \phi}{\partial z^2} = 0$; $\frac{\partial \phi}{\partial z} = 0$ at $z = 0$	
	γ	

	rJ = Hmg man VW2U2
	H=H (v2 v2) 111 d - st-h 2 g
	V2 71 2 =H +h; +hv +i v 2 o b 2g
	cp _ gli cosh k(d + z,) · (/.-- _ - /.d sm ,.x: o- t)
	2cr cos 1 < 817 /317
	w = - + u- at z =11 8t 0X I-I
	TJ = fl cos ?Ti c4 - t) l) = - cos (k.x -·- o- t) 2 - L T 2
	/gL 2Tid 0-2 = gk tanhkd C= v-tanh-- 2'1T L
	gT2 C - aT jgdT Lo=- o - 2Ti L = 21T
	F = Cc1 pgD FI2 n.cos - (- a-t) 8 - D' + C mPg -rr 8 fl tanh kd sin (- o-l)

$$1v.f = -\frac{Cd}{8} wD JJ^7 n \cos^7(-crr)d. \left[J \frac{}{2} + \frac{J}{2,n} + C 2 + \frac{1 \cdot \cosh 2kd}{lkd \sinh 2k.d}\right]$$

$$+ C_m \frac{g}{} P\frac{8}{8\tau\tau} D2 \; lid \tanh kd \; \dot{s}rn(-ut) \left[1 + \frac{1 \cdot /,d \; \cosh \; 1}{c \; srn \; 1 \; cd}\right]$$

	$C = \frac{gT}{2'lT}$ tan1 $\frac{2Tid}{L}$ Co = f √2TI
	$L = \frac{gT^2}{2Tl}$ tanh $\frac{2Tid}{L}$
	$P = \frac{pgH^2 L}{16T}\left(1 + \frac{2kd}{\sinh 2kd}\right)$ E (2kd) P= 2T 1+ s1nb 2kd
	n = $\frac{1}{2}\left(1 + \frac{2kd}{\text{sm h } 2kd}\right)$
	11· = $\frac{-rrH}{T}$ [sinh k(d + :)] / sm hkd sm x – crt)
	. (k
	LI = $\frac{-rrH}{T}$ [cosh k(d + z)] / sinhkd cos (I {x — O-f)

$\frac{C}{Co} = \frac{L}{Lo} = \tanh \frac{2Tid}{L}$

k = 2-rr/ L(wave nun1ber)

a = 2-rr /T(wave an_gu]ar f'ret1uencv)