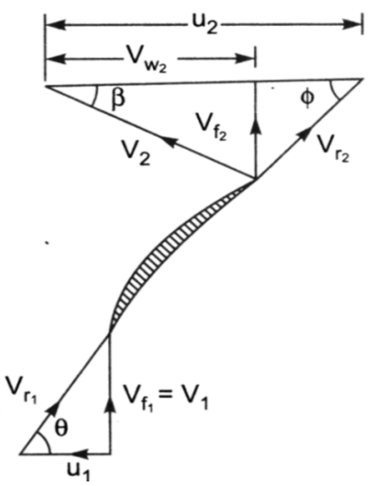
The internal and external diameter of an impeller of a centrifugal pump which is running at 1450 rpm are 150 mm and 350 mm respectively. The discharge through pump is 0.08 m3/s and the velocity of flow is constant and equal to 0.8 m/s. The diameters of the suction and delivery pipes are 80 mm and 60 mm respectively and suction and delivery heads are 6 m (abs.) and 30 m (abs.) of water respectively. If the outlet vane angle is 45 ° and power required to drive the pump is 56.186 kW, determine (i) Vane angle of the impeller at inlet, (ii)the overall efficiency of the pump, and (iii) manometric efficiency of the pump.

N	1450	rpm		
Internal dia D1	150	mm	0.15	m
External dia D2	350	mm	0.35	m
Diacharge Q	0.08	m3/s		
Velocity of flow Vf1=Vf2	0.8	m/s		
Dia of suction pipe Ds	80	mm	0.08	m
Dia of suction pipe Dd	60	mm	0.06	m
Suction head hs	6	m		
Delivery head hd	30	m		
Outlet vane angle ø	45	°		
Power required to drive pump P	56.186	kW		

$u_1=\pi D_1 N/60$	**11.39**	m/s
tan ɵ = Vf_1/u_1	**0.0703**	
Inlet vane angle ɵ	**4.02**	°



Hm=(Po/ρg+Vo2/2g+Zo)-(Pi/ρg+Vi2/2g+Zi), where o = outlet and i = inlet

Zo=Zi ; and Vo = Vd ; Vi = Vs ; Po/ρg=hd ; Pi/ρg = hs

Vd	**28.30**	m/s	$Q=Vd*\pi/4*D_d^2$
Vs	**15.92**	m/s	$Q=Vs*\pi/4*D_s^2$
Hm	**51.90**	m	

Overall efficiency (**ηo**)=(WH_m/1000)/S.P.

Overall efficiency (**ηo**)=(γQH_m/1000)/(S.P.*1000 in W)	**0.72**	or	72.5	%
		eff ok		

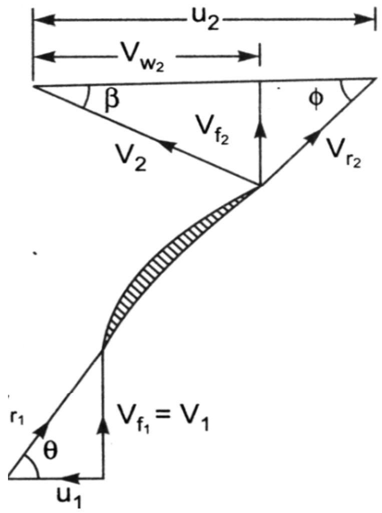
Manometric efficiency (η_{man})=$gH_m/(V_{w2}u_2)$

$u_2=\pi D_2 N/60$	**26.57**	m/s		
tan $ø=V_{f2}/(u_2-V_{w2})$; **V_{w2}=**	**25.77**	m/s		
η_{man}	**0.744**	or	74.4	%

Find the power required to drive a centrifugal pump which delivers 0.04 m3/s of the water to a height of 20 m through a 15 cm diameter pipe and 100 m long. Assume velocity of the water will be constant throughout the pump. The overall efficiency of the pump is 70% and coefficient of friction f = 0.015 in the formula h_f = $4*fLV^2/(d*2g)$

Q	0.04	m3/s		
Hs=hs+hd	20	m		
Dia of pipe Ds = Dd=	15	cm	0.15	m
Length Ls+Ld = L	100	m		
overall efficiency, η_o	0.7			
f	0.015			
Vel of water pipe Vs= Vd = **V**=$Q/(\pi/4*D^2)$	**2.26**	m/s		
Frictional head loss in pipe (**hfs+hd**)=$4*fLV^2/(2Dg)$	**10.45**	m		
Manometric head (**H_m**)=$(h_s+h_d)+(h_{fs}+h_{fd})+Vd^2/2g$	**30.71**	m		
Overall efficiency $(\eta_o)=(WH_m/1000)/S.P.$, So, **S.P.**=	**17.22**	kW	W=ρg and S.P.=power required to drive the pump	

A centrifugal pump is running at 1000 rpm The outlet vane angle of the impeller is 45° and velocity of flow at outlet is 2.5 m/s. The discharge through the pump is 200 lit/s when the pump is working against a total head of 20 m. If the manometric efficiency of the pump is 80 %, determine the diameter (outside) of the impeller, and the width of the impeller at outlet.



N	1000 rpm		
Outlet vane angle ø	45 °		
Velocity of flow at outlet V_{f2}	2.5 m/s		
Discharge Q	200 lit/s	0.2 m3/s	
Head Hm	20 m		
Manometric efficiency η_{man}	0.8		

Manometric efficiency $(\eta_{man})=gH_m/(V_{w2}u_2)$ ------(1)

$V_{w2}u_2$ **245.25**

tan $ø=V_{f2}/(u_2-V_{w2})$ so, $V_{w2}=u_2-C$ -----(2)

C **2.50**

from above equation (1) & (2), $u_2^2-C*u_2-V_{w2}u_2=0$, $u_2(1)=(C+sqrt(C^2+4*V_{w2}u_2))/2$ and $u_2(2)=(C-sqrt(C^2+4*V_{w2}u_2))/2$

$u_2(1)$	**16.96**	**ACCEPTED**	*u_2 should be positive, then accepted
$u_2(2)$	**-14.46**	**NOT ACCEPTED**	
D_2	**0.324** m	324.0 mm	(use, $u=\pi DN/60$)

Width of the impeller (B_2), use $Q=\pi D_2NB_2V_{f2}$

B_2	**0.079** m	78.61 mm