"Turbo"
"Zhaoyi Jiang (.1364)"
"HW4"
"P1"

```
H=300[m]
Q=4.2[m^3/s]
r2=0.75[m]
rpm=450
phi=0.98
beta_3=65[degree]
psi=0.9
g=9.81[m/s^2]

c1_th=(2*g*H)^0.5
c1=phi*c1_th
u=450/60[s]*r2*2*pi
W=u*(c1-u)*(1+sin(beta_3))
eta_h=W/(g*H)

Wt_dot=1000[kg/m^3]*Q*W
Weff_dot=Wt_dot*0.9

Q/5=pi*r^2*c1
d=r*2
```

SOLUTION

Unit Settings: SI C kPa kJ mass deg

β_3 = 65 [Degree]
$c1_{th}$ = 76.72 [m/s]
η_h = 0.9121
H = 300 [m]
ψ = 0.9
r = 0.05963 [m]
rpm = 450 [rpm]
W = 2684 [m^2/s^2]
$\dot{W}t$ = 1.127E+07 [w]

c1 = 75.19 [m/s]
d = 0.1193 [m]
g = 9.81 [m/s^2]
ϕ = 0.98
Q = 4.2 [m^3/s]
r2 = 0.75 [m]
u = 35.34 [m/s]
$\dot{W}eff$ = 1.015E+07 [w]

No unit problems were detected.

"Turbo"
"Zhaoyi Jiang (.1364)"
"HW4"
"P2"

```
H=150[m]
Q=4.5[m^3/s]
r2=0.6[m]
rpm=450
alpha_2=72[degree]
c2=53.3[m/s]
g=9.81[m/s^2]

c2_th=(2*g*H)^0.5
phi=c2/c2_th
u1=450/60[s]*r2*2*pi
c2u=c2*sin(alpha_2)
w2u=c2u-u1
w2r=c2*cos(alpha_2)
beta_2=arctan(w2u/w2r)

W_dot=1000[kg/m^3]*Q*g*H*phi
omega=450/60[s]*2*pi
T=W_dot/omega
```

SOLUTION

Unit Settings: SI C kPa kJ mass deg

α_2 = 72 [Degree]	β_2 = 53.69 [degree]
c2 = 53.3 [m/s]	c2u = 50.69 [m/s]
$c2_{th}$ = 54.25 [m/s]	g = 9.81 [m/s^2]
H = 150 [m]	ω = 47.12 [rad/s]
ϕ = 0.9825	Q = 4.5 [m^3/s]
r2 = 0.6 [m]	rpm = 450
T = 138059 [N*m]	u1 = 28.27 [m/s]
w2r = 16.47 [m/s]	w2u = 22.42 [m/s]
$\dot{W}$ = 6.506E+06 [W]	

No unit problems were detected.

"Turbo"
"Zhaoyi Jiang (.1364)"
"HW4"
"P3"

va=12[m/s]
r=20[m]
lambda=4
cp=0.3
rho= 1.225[kg/m^3]

W_dot=0.5*rho*(pi*r^2)*va^3
lambda=w*r/va
omega=w/2/pi
"cp=4*a*(1-a)^2"
a=0.091
vd=(1-a)*va
vb=(1-2*a)*va
pa=1[bar]
pa***convert**(bar,pa)/rho+0.5*va^2=p1*convert(bar,pa)/rho+0.5*vd^2

SOLUTION
Unit Settings: SI C bar kJ mass deg

a = 0.091	cp = 0.3
λ = 4	ω = 0.382 [rpm]
p1 = 1 [bar]	pa = 1 [bar]
r = 20 [m]	ρ = 1.225 [kg/m^3]
va = 12 [m/s]	vb = 9.816 [m/s]
vd = 10.91 [m/s]	w = 2.4 [rad/s]
$\dot{W}$ = 1.330E+06 [W]	

1 potential unit problem was detected.

"Turbo"
"Zhaoyi Jiang (.1364)"
"HW4"
"P4"

```
va=12[m/s]
N=60
rt=5.2[m]
rh=0.4[m]
c=0.4[m]
cl=0.3
cd=0.018
beta_2=60[degree]

c1=va
omega=pi*60/30
lambda=omega*rt/va
rm=(rt+rh)/2
um=omega*rm
beta_1=arctan(um/c1)
w1=(c1^2+um^2)^0.5
w2=w1*cos(beta_1)/cos(beta_2)
cz2=w1*cos(beta_1)
ca2=w2*sin(beta_2)-um
alpha_2=arctan(ca2/cz2)
c2=(ca2^2+cz2^2)^0.5
tan(beta_m)=0.5*(tan(beta_1)+tan(beta_2))
wm=cz2/cos(beta_m)
Fum=0.5*(1.2[kg/m^3])*wm^2*c*(cl*sin(beta_m)-cd*cos(beta_m))
Fzm=0.5*(1.2[kg/m^3])*wm^2*c*(cl*cos(beta_m)-cd*sin(beta_m))
zb=12/lambda
w_dot=zb*Fum*um*(rt-rh)
Od=(rt^2-rh^2)*pi
cp=2*w_dot/(1.2[kg/m^3]*Od*va^3)
```

SOLUTION

Unit Settings: SI C bar kJ mass deg

α_2 = 14.89 [degree]	β_1 = 55.7 [degree]
β_2 = 60 [Degree]	β_m = 57.98 [degree]
c = 0.4 [m]	c1 = 12 [m/s]
c2 = 12.42 [m/s]	ca2 = 3.192 [m/s]
cd = 0.018	cl = 0.3
cp = 0.1279	cz2 = 12 [m/s]
Fum = 30.09 [N/m]	Fzm = 17.68 [n/m]
λ = 2.723	N = 60
Od = 84.45 [m^2]	ω = 6.283 [rad/s]
rh = 0.4 [m]	rm = 2.8 [m]
rt = 5.2 [m]	um = 17.59 [m/s]
va = 12 [m/s]	w1 = 21.3 [m/s]
w2 = 24 [m/s]	wm = 22.63 [m/s]
$\dot{w}$ = 11201 [W]	zb = 4.407

No unit problems were detected.