Tutorial Problems for exercise

1. A 3-D design of a rotor blade of axial flow compressor following vortex laws may be used :

$$C_{w1} = (aR-b)/R \qquad \text{and} \qquad C_{w2} = (aR+b)/R$$

Where $R = r/r_{mean}$

And following data may be used : hub/tip radius ratio,

$r_h / r_t = 0.6$; C_a = constant across the rotor at mean radius

At mean radius $C_{w1} = 60$ m/s ; $C_{w2} = 150$ m/s

Specific work = 21.6 kJ/kg

Calculate the following parameters :

i) at mean radius : ΔT, Rx, a, b

ii) at root and tip, Rx

iii) at root and tip : inlet and exit axial velocities, C_{a1} , C_{a2}

iv) Inlet and exit flow angles at root, mean and tip

2) The table here shows a few data of an axial flow compressor rotor designed with Free vortex theory.

i) Calculate all the data to complete the table

ii) Plot the entry and exit velocity triangles at root, mean and tip

Variable	Root Section	Mean Section	Tip Section
C_{w1} [m/s]	32	24	?
C_{w2} [m/s]	?	150	?
$R[r/r_m]$	?	?	?
U_1 [m/s]	?	?	?
U_2 [m/s]	?	?	?
R_x	?	?	?
C_{a1} [m/s]	109	?	?
C_{a2} [m/s]	?	?	?
ΔT_0 [K]	?	?	?
$U\Delta C_w$ [J/kg]	?	?	?
α_1 [°]	?	?	?
α_2 [°]	?	?	?
β_1 [°]	?	?	?
β_2 [°]	?	?	?
Chord [cm]	6.0	5.5	5.0

3. An axial flow compressor with hub/tip radius ratio of 0.4 and maximum diameter as 0.6m, has been designed with constant reaction of 50% from root to tip . The blade tip speed U_{tip} = 300 m/s. The stagnation temperature rise is 16^0 C. The axial velocity prescribed for the flow near the casing, upstream of rotor, is 120 m/s. For air c_p = 1.005 kJ/kgK.

Determine the axial velocity before and after the rotor such that radial equilibrium is maintained.

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