CIMDes ReadMe

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CIMDes is a centrifugal impeller meanline design code. It performs 1D analysis of centrifugal impeller for single and multi-stages. Below are the instructions to run it.

CIMDes is a Python script and it can be run from any machine which has Python 3.6 installed.

Inputs: cimdes.py, the inputs are in the python script itself.

Outputs: veltri.png – image of velocity triangles at the hub.
streamlines.png – flow path in x-r coordinates.
bladerow.png – relative blade angles image
tblade3input.rownumber.casename.dat – input file for T-blade3.
meanlineflowproperties.dat – flow properties along the meanline.

Command to run the code: Go to the directory containing the code.
In that directory type the following.

>**[code_directory path\]python cimdes.py**

This creates above mentioned output files.

INPUTS

All the inputs are mentioned in the script. It contains the inlet, stage and geometrical properties of compressor to be designed. All the units are in SI system unless otherwise mentioned.

1. **Input Parameters**

The input parameters are conditions at inlet and overall compressor. The following are the details as it appears in the code.

Symbol	Description	Units
casename		-
N	Rotations per minute	*rpm*
mdot	Mass Flow Rate	*kg/s*
Rgas	Gas Constant	*J/kg-K*
Cp	Specific heat capacity at constant pressure	*J/kg-K*
PR	Overall Impeller Pressure Ratio	-
Z	Number of blades	-
nsect	Number of Streamlines	-

Table 1 Input data.

2. Stage Parameters

Symbol	Description	Units
PR_SingleStage	Single Stage Pressure Ratio	-
Eta_SingleStage	Single stage efficiency	-
Eta_R1	Rotor 1 Efficiency	-
Eta_R2	Rotor 2 Efficiency	-
WorkRatio_R1	Ratio of work done by rotor 1	-
dalpha	Stator turning angle	*deg*
Y	Stator Total Pressure Loss Co-efficient	-
Beta6_Blade	Backsweep Angle	*deg*

Table 2 Stage parameters data.

3. Inlet Conditions

Symbol	Description	Units
P01	Inlet total pressure	*Pa*
T01	Inlet total temperature	*K*
Vt1	Tangential velocity at inlet	*m^2 /s*
Beta1_Blade	Relative flow angle at inlet	*deg*

Table 3 Inlet conditions.

4. Flowpath parameters

Symbol	Description	Units
R_hub_le	LE r-coordinate at hub	*m*
R_tip_le	LE r-coordinate at tip	*m*
R_hub_te	TE r-coordinate at hub	*m*
R_tip_te	TE r-coordinate at tip	*m*
(X_hub, R _hub)	Co-ordinates for hub center	*m*
R	Radius of hub	*m*
(X_tip , R _tip)	Co-ordinates for tip center	*m*
a	major axis of ellipse	*m*
b	minor axis of ellipse	*m*

Table 4 Inputs to create streamline at hub and shroud.

APPENDIX

A. Inputs for CIMDes for multi-stage centrifugal impeller

```
#----------------------------Input Parameters--------------------------------
casename = "MS_1.5"
N = 22363                               #Speed of Impeller [rpm]
mdot = 4                                #Mass flow rate [kg/s]
Rgas = 287                              #Gas constant of Air [J/kg-K]
Cp = 1006                               #Specific constant at constant pressure [J/kg-K]
PR = 4.8                                #Overall Pressure Ratio
Z = [24,24,24]                          #Number of Blades [-]
nsect = 5                               #Number of streamlines

#----------------------------Stage Parameters--------------------------------
PR_SingleStage = 4.7                    #Overall Pressure ratio Single stage
Eta_SingleStage = 0.94                  #Overall efficiency single stage

Eta_R1 = 0.97                           #Rotor 1 Efficiency
Eta_R2 = 0.95                           #Rotor 2 Efficiency
WorkRatio_R1 = 0.35                     #Ratio of work done by Rotor 1
dalpha = 25                             #Stator turning angle [deg]
Y = 0.03                                #Total Pressure loss coefficient across stator [-]
Beta6_Blade = -30                       #Backsweep angle [deg]

#----------------------------Inlet Conditions--------------------------------
P01 = 101325                            #Inlet Pressure [Pa]
T01 = 300                               #Inlet Temperature [K]
Vt1 = 0                                 #Inlet Tangentail Velocity[m^2/s]
Beta1_Blade = np.array([-36,-62] )      #Inlet relative flow angle[deg]

#----------------------------Flowpath Parameters-----------------------------
R_hub_le = 0.0449341
R_tip_le = 0.11274362
R_hub_te = 0.2
R_tip_te = 0.2

[X01, R01] = [-0.065005893244729426, 0.21920467299175289]     #(x,r)-coordinates for center of circle for hub
R = 0.186                           #Radius of the circle

[X04,R04] = [0,0.209]             #(x,r)-coordinates for center of ellipse for shroud
[a,b] = [0.105761,R04-R_tip_le]
```

Figure 1 Sample input parameters for 1.5 stage centrifugal impeller.

B. Output of flow parameters at meanline

```
Row     Solidity     DF     DeHallerNumber       Rx        phi
01       1.8344   0.8808     0.3766          0.5338     0.4610
02       1.7618   -1.6926     2.4059         0.4580     0.4121
03       1.8045   0.1004     1.2233          0.4420     0.8144

Station     Swirl    Vt[m/s]     Vm[m/s]     T[k]        Mach
01     0.0000     0.0000     160.4952     287.1975     0.4726
02     26.6333     355.1109     103.4123     319.5977     1.0324
03     13.6415     111.3594     104.9393     351.3265     0.4074
04     63.1034     315.5170     264.7484     392.8250     1.0370


Overall Pressure ratio = 4.8000
Overall Efficiency = 0.9559

Rotor 1 Pressure ratio = 1.8973
Rotor 1 Efficiency = 0.9700

Rotor 2 Pressure ratio = 2.5570
Rotor 2 Efficiency = 0.9656
```

Figure 2 Sample output of meanlineflowparameters.dat for 1.5 stage centrifugal impeller.