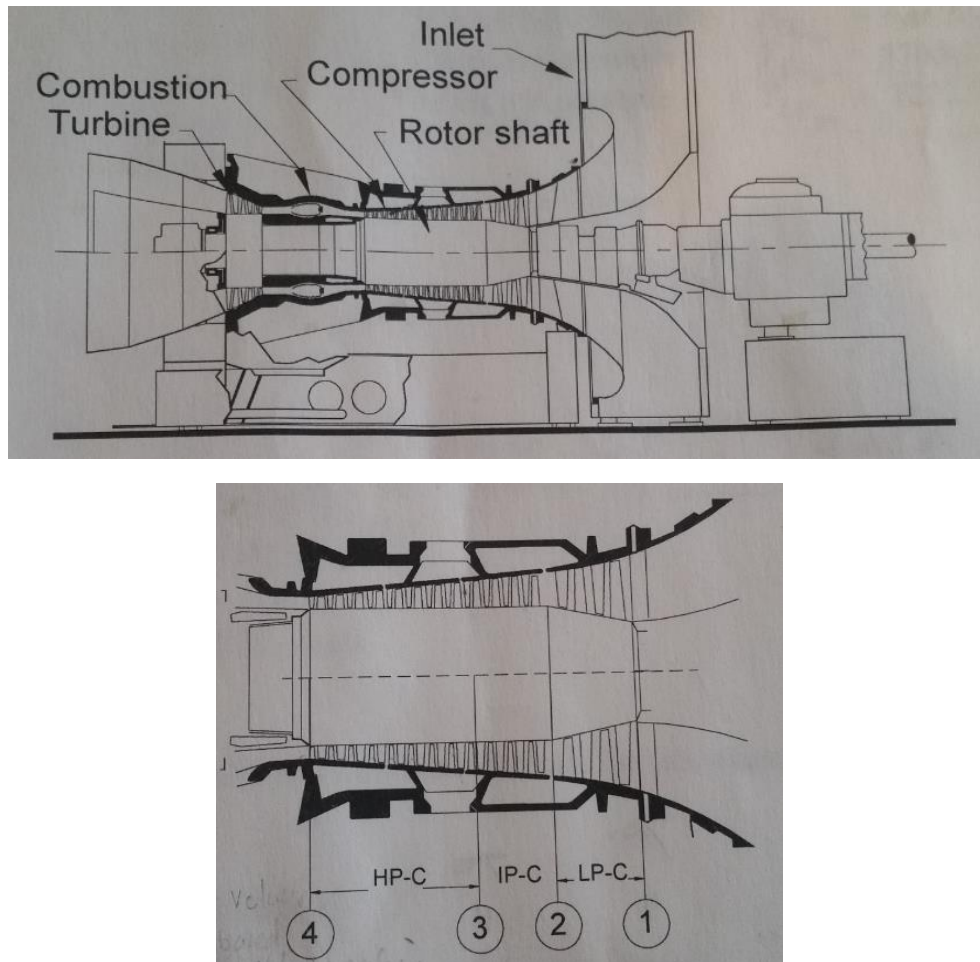


**MEEN-414-646: M4 – Design competition (Spring, 2016)**

**AeroThermo-Mechanical Design of a Power Generation Gas Turbine Engine**



**Fig. 1:** Power generation gas turbine to be designed

A power generation gas turbine engine sketched in Fig.1 needs to be designed. The compressor may be decomposed into a Low Pressure (LP), Intermediate Pressure (IP) and a High Pressure (HP) Part. The gas turbine has the following data:

**LP-Compressor**

|                                |              |        |       |
|--------------------------------|--------------|--------|-------|
| <b>Mass flow</b>               | $\dot{m}$    | 150.0  | kg/s  |
| <b>Inlet static pressure</b>   | $p_{in}$     | 98.61  | kPa   |
| <b>Pressure ratio</b>          | $\Pi_{LP}$   | 1.8048 |       |
| <b>Inlet total temperature</b> | $T_{0in}$    | 288.21 | K     |
| <b>Exit total temperature</b>  | $T_{0out}$   | 347.2  | K     |
| <b>Inlet mean diameter</b>     | $D_{m\_in}$  | 1.2043 | m     |
| <b>Exit mean diameter</b>      | $D_{m\_out}$ | 1.1253 | m     |
| <b>Angular velocity</b>        | $\omega$     | 469.35 | rad/s |

**IP-Compressor**

|                                |              |        |       |
|--------------------------------|--------------|--------|-------|
| <b>Mass flow</b>               | $\dot{m}$    | 150.0  | kg/s  |
| <b>Inlet static pressure</b>   | $p_{in}$     | 177.97 | kPa   |
| <b>Pressure ratio</b>          | $\Pi_{IP}$   | 1.6739 |       |
| <b>Inlet total temperature</b> | $T_{0in}$    | 347.02 | K     |
| <b>Exit total temperature</b>  | $T_{0out}$   | 407.51 | K     |
| <b>Inlet mean diameter</b>     | $D_{m\_in}$  | 1.1253 | m     |
| <b>Exit mean diameter</b>      | $D_{m\_out}$ | 1.0809 | m     |
| <b>Angular velocity</b>        | $\omega$     | 469.35 | rad/s |

**HP-Compressor**

|                                |              |        |       |
|--------------------------------|--------------|--------|-------|
| <b>Mass flow</b>               | $\dot{m}$    | 150.0  | kg/s  |
| <b>Inlet static pressure</b>   | $p_{in}$     | 297.01 | kPa   |
| <b>Pressure ratio</b>          | $\Pi_{HP}$   | 3.0629 |       |
| <b>Inlet total temperature</b> | $T_{0in}$    | 407.51 | K     |
| <b>Exit total temperature</b>  | $T_{0out}$   | 576.89 | K     |
| <b>Inlet mean diameter</b>     | $D_{m\_in}$  | 1.0809 | m     |
| <b>Exit mean diameter</b>      | $D_{m\_out}$ | 1.0130 | m     |
| <b>Angular velocity</b>        | $\omega$     | 469.35 | rad/s |

**Combustion chamber**

|                              |                  |        |      |
|------------------------------|------------------|--------|------|
| <b>Inlet static pressure</b> | $P_{ccin}$       | 909.74 | kPa  |
| <b>Exit static pressure</b>  | $P_{ccout}$      | 873.35 | kPa  |
| <b>Inlet temperature</b>     | $T_{ccin}$       | 576.89 | K    |
| <b>Exit temperature</b>      | $T_{ccout}$      | 1222.7 | K    |
| <b>Air mass flow</b>         | $\dot{m}_{air}$  | 150    | kg/s |
| <b>Fuel mass flow</b>        | $\dot{m}_{fuel}$ | 2.97   | kg/s |

**Turbine**

|                              |              |        |     |
|------------------------------|--------------|--------|-----|
| <b>Inlet static pressure</b> | $P_{in}$     | 873.35 | kPa |
| <b>Exit pressure</b>         | $P_{out}$    | 102.2  | kPa |
| <b>Inlet temperature</b>     | $T_{in}$     | 1222.7 | K   |
| <b>Inlet mean diameter</b>   | $D_{m\_in}$  | 1.062  | m   |
| <b>Exit temperature</b>      | $T_{out}$    | 806.77 | K   |
| <b>Exit mean diameter</b>    | $D_{m\_out}$ | 1.12   | m   |

**Tasks:**

- Inlet nozzle, compressor calculation
- Turbine, diffuser exit calculation
- Combustion chamber calculation
- Solid work design
- Solid mechanics calculation