AS 3270 Propulsion - PART A - Dr. T. M. Muruganandam

Assignment – 1, **Due: Oct 02, 2016, 1PM** **Total score: 30, Weightage: 10%**

Assignment must be submitted ***only electronically*** *to tmmuruganandam@gmail.com (.pdf or .doc file) within the deadline. Date stamp on the email received will be used as submission time. -2 % of grade for every half hour of delay. So if you submit beyond 6 pm, it is useless even if you get full score.* *Assignment must be typed in and No need to give the formulas in the report. Do all calculations in SI units. You NEED to attach the codes/worksheets used to produce the plots. The codes must work in my computer, so attach any required submodules for the code. If I suspect copying, each of the suspects earn -4% of grade.* *Give references of sources, if quoting data from somewhere other than this assignment.*

1. Consider a High bypass Turbofan engine. The fan and the compressor are on a single shaft run by a single turbine. The incoming air either goes through the fan and goes to the cold flow nozzle or goes through the gas generator and goes through the hot flow nozzle. Bypass ratio, B, is defined as the ratio of cold to hot mass flow rates of air. There is no after burner in this engine.

a. Plot the Specific Thrust and TSFC as a function of compressor pressure ratio (range = 3 to 50) for two T_{04} values of 1630 K&1730K for B= 5. Explain the results. **[8]**

b. Do the same for B=10 keeping all the parameters same. Explain the differences. **[4]**

c. Plot the thermal and propulsion efficiency variations with compressor ratio for bypass ratios of zero, 5 and 10 for T_{04}=1630K. Explain the results **[8]**

Data for the engine:

T_∞ =220K, P_∞ = 0.25atm, M_∞= 0.85, assume that c_p is constant throughout, and γ =1.4
Compressor pressure ratio = 20, Fan pressure ratio= P_{rf} = 1.72, T_{04} = 1630K, B= 5.
η_{diff} =0.93, η_{fan} =0.85, η_{n_cold} =0.98, η_{comp} =0.85, η_{burner} =1, η_{turb} =0.85, η_{n_hot} =0.98,
ΔP_{o_burner}=0. Heat released per kg of **JP4** fuel = 45000 kJ/kg.

2. Let us calculate the performance parameters for the Tumansky RD-9 engine in our dept.

a. List the Po & To for each stage of the engine. **[5]**

b. Calculate the Specific Thrust, TSFC and the propulsive, thermal and overall efficiencies for the engine, with and without afterburner, operating at maximum specific thrust configurations. **[5]**

Data for Tumansky RD-9 engine: (Turbojet engine with after burner)

T_∞ =220K, P_∞ = 0.25atm, M_∞= 0.85, assume that c_p is constant throughout, and γ =1.4
Compressor pressure ratio = 7.2, T_{04} = 857^{o}C, T_{06} = 927^{o}C, m_dot_air=48 kg/s
η_{diff} =0.97, η_{comp} =0.835, η_b =0.95, η_{turb} =0.865, η_{ab} =0.5, η_n =0.98,
ΔP_{o_burner}=0. $\Delta P_{o\_afterburner}$=0. Heat released per kg of **JP4** fuel = 45 MJ/kg.

3. [Bonus] a. What are the materials used for burner, compressor blades and turbine blades in current gas turbine engines? Cite your sources. **[3]**

b. Should a turbofan engine have a stator following the fan for the cold stream? Discuss. **[3]**