

Practice problems # 3 (Submission Due date: 29th February, 2020 in Class)

1. Boeing 777 aircraft is powered by four CF-6 turbofan engines manufactured by General Electric Company. Each engine has the following data:

Thrust force	24.0 KN
Air mass flow rate	125 Kg/s
By pass ratio	5.0
Fuel mass flow rate	0.75 Kg/s
Operating Mach number	0.8
Altitude	10 Km
Ambient temperature	223.2 K
Ambient pressure	26.4 KPa
Fuel heating value	42,800 KJ/Kg

If the thrust generated from the fan is 75% of the total thrust, determine the following assuming that the exit pressures of the cold and hot streams are equal to the ambient pressure.

- (i) The jet velocities of the cold air and hot gases
- (ii) The specific thrust
- (iii) TSFC
- (iv) The propulsive efficiency
- (v) The thermal efficiency
- (vi) The overall efficiency

[40 points]

2. A three-spool turbofan (forward fan) engine has the following data:

Fan pressure ratio	1.42:1
Overall compressor pressure ratio	25
HPC pressure ratio	5
BPR	5:1
Fan air mass flow rate	500 Kg/s
Fuel-to-air ratio (at take-off thrust)	0.0177
Ambient pressure	1.0 bar
Ambient temperature	288 K
Total pressure recovery at inlet	98%
Fan efficiency	0.99
Intermediate compressor efficiency	0.89
HPC efficiency	0.9
HPT efficiency	0.9

Intermediate pressure turbine efficiency	0.9
LPT efficiency	0.9
Combustion chamber efficiency	0.98
Mechanical efficiency	0.99
Percentage bleeding air of core mass flow	2%
Fuel heating value	45,000 kJ/Kg
Hot gases nozzle and fan nozzle efficiency	0.87
Percentage total pressure drop in the combustion chamber relative to HPC	2%
Percentage pressure losses in the jet pipe relative to LPT	2%
Engine weight	28.8 kN
Maximum diameter	2172 mm
Maximum frontal area	2.79 m ²

Calculate the take-off thrust at M=0.2. ($\gamma_t=1.33$, $C_{pt}=1.147$ kJ/Kg-K; for all elements up to the Combustion chamber $\gamma=1.4$, $C_p=1.005$ kJ

[60 points]