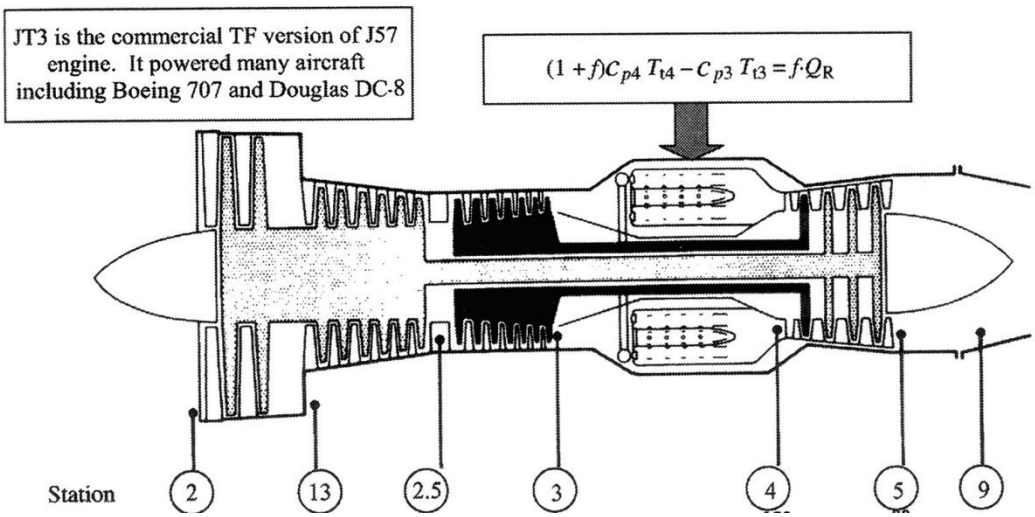
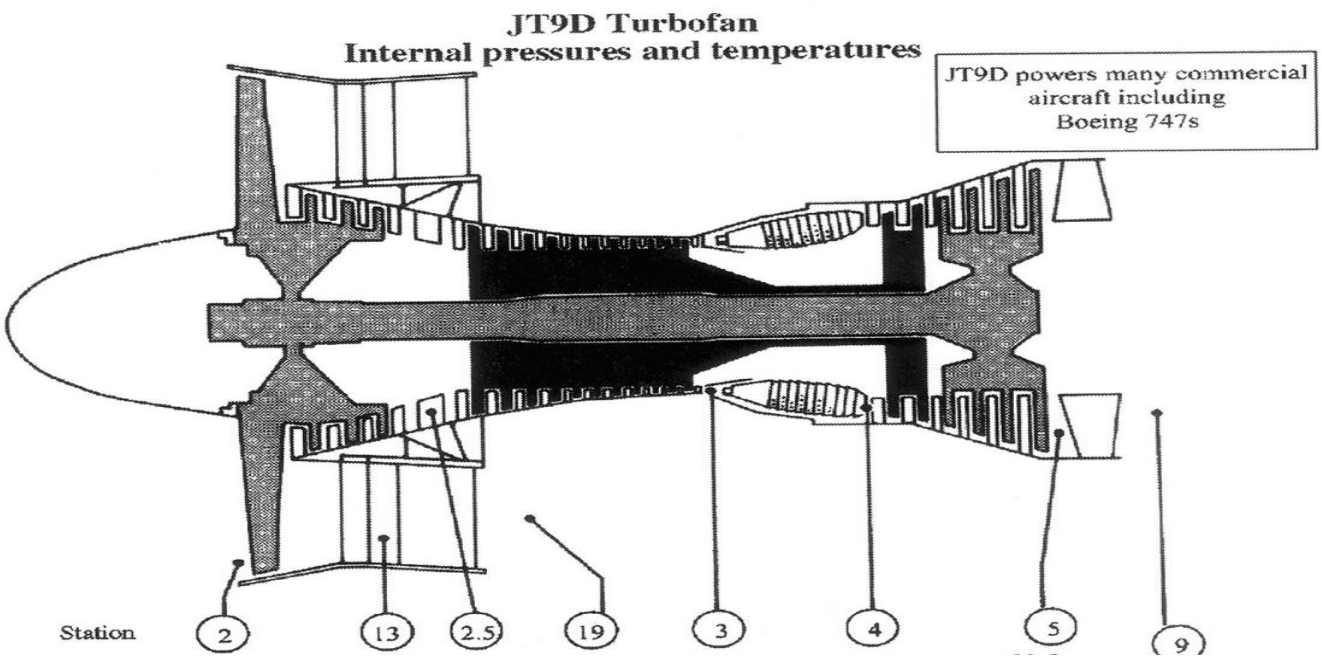
Sheet 1

1. Fig s (1) , (2) show the total pressures and temperatures of the gas for Pratt & Whitney (JT3D-3B0 from, 1974, for the sea level static operation.



P_t [bar]	1.013	1.52	4.34	13.79	13.1	1.93
T_t [k]	288			652.4	1033	750

Fig. (1) JT3D-3B Turbofan Internal pressures and temperatures**. At sea level static conditions the thrust is 80064 N $\dot{m}_F$ =120.2 kg/s , $\dot{m}_C$ =88.45 kg/s ,** V_{JCore}= 475.5 m/s



Station	2	1.3	2.5	1.9	3	4	4.5	5	9
P_t [bar]	0.379	0.655			11.86				
T_t [K]	262.2					1404		735.6	
$\dot{m}$ [kg/s]	269.9			217.27					

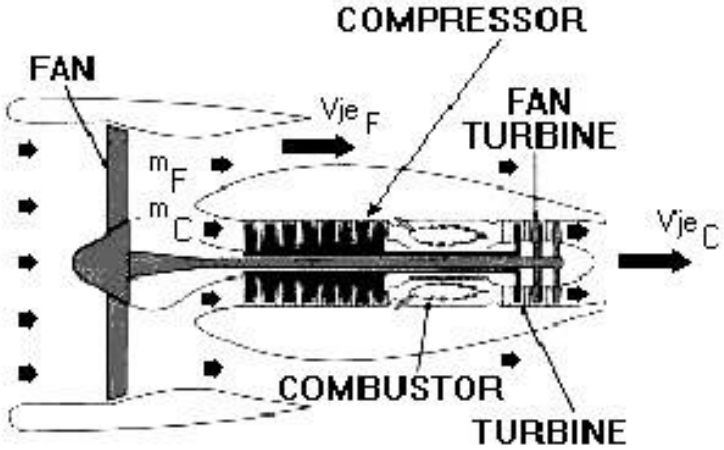
Fig. (2) JT9D turbofan engine internal pressures and temperatures. At cruise conditions. V_F= 324.3 m/s , V_C= 493.8 m/s.

Determine and compare for both engines:

(a) Engine bypass ratio.
(b) Fuel-to-air ratio and the fuel flow rate in kg/h, assuming the fuel heating value is $Q_R=2.8.10^7$ J/kg and the specific heat at constant pressure is 1004.5 and 1088 J/kg.°k at the entrance and exit to the burner, respectively.
(c) Fan, core and total static thrust assuming perfectly expanded nozzles, and compare your answers to the specified thrust.
(d) Effective jet velocity, specific thrust.
(e) Thermal efficiency.
(f) Engine thrust specific fuel consumption [mg/N.s].
(g) Fan and core nozzles exit Mach number.

2. a- **Plot** the thrust specific fuel consumption (S) versus the specific thrust, at sea level static conditions (SLS), for some typical turbojet and turbofan engines. Indicate the bypass ratio. Is there any correlation for the engine thrust to weight ratio (F/W_{eng}) with engine type and/or specific thrust?

   b- Evaluate the thermal efficiency of each case. Attempt to relate the thermal efficiency to engine performance parameters [compressor overall pressure ratio (OPR), turbine inlet temperature (TIT)]



Two stream Turbofan engine.

3. A turbofan engine cruises at M_0=0.85 and altitude of 34 000 ft. The fan and core effective jet velocities are 370 m/s and 490 m/s respectively. The total air mass flow rate is 275 kg/s and the bypass ratio (α) is 4.3. The engine has an overall pressure ratio of 31.3 and maximum turbine inlet temperature (TIT) of 1400 K. Assuming ideal intake, compressors and combustion chamber, determine:

   a-Combustion chamber "ideal" fuel air ratio.

   b-Thrust, various efficiencies ($\eta_{th}, \eta_p, \eta_O$), and specific fuel consumption.

4- Prove that for a two stream, turbofan engine, with a constant sum of "relative" kinetic power, the thrust and propulsive efficiency are maximum when $V_{Je\,F} = V_{Je\,C}$.

5- Show that; at static conditions, if two gas turbine engines receive the same fuel flow rate, with the same "*relevant"* efficiency (*which one*?), the engine that passes more airflow rate will produce higher thrust.