Example of ideal turbofan engine calculation

Assumption and given:

Data:			
		value	unit
altitude	H	11	km
ambient temperature	T_0	217	K
ambient pressure	p_0	22.6	kPa
TIT turbine inlet temperature	T_{t4}	1500	K
Compressor pressure ratio	Π_{ct}	15	K
Flight Mach Number	Ma_0	0.8	[-]
air mass flow	m_c	10	kg/s
air heat value	Cp_c	1005	J/kg*K
compressor/air isentropic index	k	1.4	[-]
gas constant - air	R_c	287	J/kg*K
turbine heat value	Cp_t	1180	J/kg*K
turbine/fume isentropic index	k'	1.33	[-]
fuel heat value	FHV	43	MJ/kg
gas constant - fume	R_t	287	J/kg*K

INLET   COMPRESSOR   BURNER   TURBINE   NOZZLE
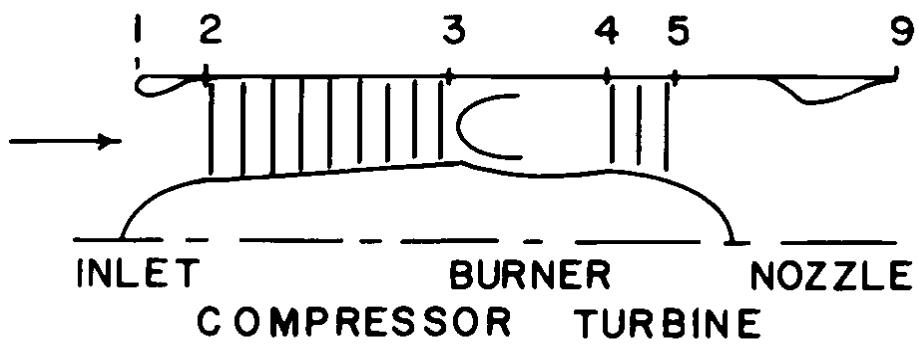
Calculation:

	parameter	value	unit
sataion 0			
total temperature	T_{t0}	244.8	K
total pressure	p_{t0}	34.5	kPa
sound speed	a_0	295.3	m/s
flight speed	V_0	236.2	m/s
station 2 compressor inlet			
total temperature	T_{t2}	244.8	K
total pressure	p_{t2}	34.5	kPa
station 3 compressor outlet			

total temperature	T_{t3}	530.6	K
total pressure	p_{t3}	516.8	kPa
compressor work	W_c	287.3	kJ/kg
compressor power	P_c	2872.9	kW

station 4 turbine inlet			
total temperature	T_{t4}	1500.0	K
total pressure	p_{t4}	516.8	kPa
stagnation entalpy ratio	τ_λ	8.12	-
fuel/air flow ratio	f	0.0288	-
fuel mas flow	m_f	0.288	kg/s
turbine mas flow	m_t	10.29	kg/s
turbine compressor relative mass flow	1+f	1.0288	-

station 5 turbine outlet			
total temperature	T_{t5}	1263.3	K
total pressure	p_{t5}	258.7	kPa

station 9 engine nozzle outlet			
total temperature	T_{t9}	1263.3	K
total pressure	p_{t9}	258.7	kPa
static pressure	p_9	22.6	kPa
static temperature	T_9	690.0	K
Mach number	Ma_9	2.2441	-
sound speed	a_9	513.2	m/s
jet speed	V_9	1151.7	m/s

Engine perforamnce parameters			
Thrust	F	9485.7	N
specific thrust	F/mc	948.6	Ns/kg
Specific fuel consumption	SFC	0.00003032	kg/(Ns)
Specific fuel consumption	SFC	0.1092	kg/(Nh)
thermal efficiency	η_{th}	0.5291	-
propulsive efficiency	η_p	0.3424	-
overal efficiency	η_o	0.1812	-