Propeller Propulsion

Cessna 421

Continental O-520 is a six-cylinder, horizontally-opposed aircraft engine produced by Teledyne Continental Motors. It produces 375 horsepower (280 kW).

**Performance**

- **Maximum speed**: 256 knots (475 km/h, 295 mph) at 20,000 ft (6,100 m)
- **Cruise speed**: 240 knots (444 km/h, 276 mph) at 25,000 ft (7,600 m) (75% power)
- **Range**: 1,487 nmi (2,755 km, 1,712 miles)
- **Service ceiling**: 30,200 ft (9,205 m)
- **Rate of climb**: 1,940 ft/min (9.9 m/s)
Radial Engines

DC 3
The **Douglas DC-3** revolutionized air transport in the 1930s and 1940s *(a few hundred remain in service as of 2018!)*
Generally regarded as one of the most significant transport aircraft ever made.
Total production of the DC-3 was 16,079.

**Performance**
- **Maximum speed:** 237 mph (206 kn, 381 km/h)
- **Cruise speed:** 150 mph (130 kn, 240 km/h)
- **Range:** 1,025 mi (890 nmi, 1,650 km)
- **Service ceiling:** 24,000 ft (7,300 m)
- **Rate of climb:** 1,130 ft/min (5.73 m/s) initial
- **Wing loading:** 25.5 lb/ft² (125 kg/m²)
- **Power/mass:** 0.0952 hp/lb (157 W/kg)

**Wright R-1820 Cyclone nine** cylinder radial engine that produced between 575 to 1,425 horsepower depending upon model and whether the engine was supercharged. It was produced in large numbers during the Second World War and continued production until the 1950’s. It was featured in such famous aircraft as early models of the Douglas DC-3, Boeing B-17 and Lockheed Lodestar.
Components of a Typical Turbojet

INTAKE

Air Inlet

Compression

Compress

Combustion

Combustion Chambers

Turbine

Exhaust

EXHAUST

Cold Section

Hot Section
The first Frank Whittle engine was called the Power Jet W.1. It flew in the British Gloster G.40 on May 15, 1941.
General Electric J79 turbojet with afterburner

Major applications:
- F-104 Starfighter
- F-4 Phantom II
- A-5 Vigilante
- B-58 Hustler
Afterburners
Highly Maneuverable Aircraft Technology.
The Rockwell *HiMAT* powered by a General Electric J85 turbojet engine, had a length of 23 feet and a wing span of 16 feet.
**PW2000 TURBOFAN ENGINE**

**Manufacturer** Pratt & Whitney  
**First run** 1980s  
**Major applications** Boeing 757, C-17 Globemaster III  
**Maximum thrust:** 38,400–43,734 pounds-force  
(171–194.54 kN)  
**Engine bypass ratio:** 5.9 to 1

**The Boeing 757-200**  
Max cruising speed 914km/h (493kt),  
Economical cruising speed 850km/h (460kt).  
Range with P&W engines and 186 passengers = 5053km (2728nm)
The Worlds most powerful turbofan engine in service
The General Electric GE90.

The Boeing 777-300ER ("ER" for Extended Range)
The standard GE90-115B turbofans are the world's most powerful jet engines in service,
with a maximum thrust of 115,300 lbf (513 kN).
The maximum range is 7,930 nautical miles (14,690 km),
GE 90
Engine bypass ratio 9 to 1
Trent 1000 turbofan engine produced by Rolls Royce.
Boeing 787
Highest engine bypass ratio 11 to 1
CF6-50 Engine
Reverse Thrust

Cascade Vanes

Fan Reverser Translating Cowl ( Deployed )

Reverse Thrust Airflow

Blocker Doors
F-22 Raptor
Lockheed Martin
Pratt & Whitney F119-PW-100 turbofan engine with afterburners (2x)
156 kN (15,900 kgp / 35,000 lbf)
Turboprop Engines
Europrop International
TP400-D6 Turboprop
Airbus A400M Military Transport Aircraft

Performance
• Cruising speed: 780 km/h (480 mph; 420 kn) (Mach 0.68 - 0.72)
• Cruise Altitude: 9,000 m (29,000 ft)
• Range at 20-tonne payload: 6,390 km (3,450 nmi)
The Predator B
Powered by a Honeywell TPE-331-10T turboprop engine driving a McCauley pusher propeller.
Output is 940 shaft horsepower at takeoff.
Ramjets (René Lorin 1913) (3<M<5)

Griffon 2 (1950’s)
Scramjets (M>5)

In May 2013 an unmanned X-51A WaveRider reached 4828 km/h (Mach 5.1) during a three-minute flight under scramjet power. On 28 August 2016, the Indian space agency ISRO conducted a successful test of a scramjet engine for about 5 seconds.
Solid Propellant Rocket Engine
The Space Shuttle Solid Rocket Boosters (SRBs)
Liquid Rocket Engine

$V$ = Velocity
$\dot{m}$ = mass flow rate
$p$ = pressure

Thrust = $F = \dot{m} V_e + (p_e - p_0) A_e$
MAE 113
FUNDAMENTALS OF PROPULSION
WINTER 2019

Topics Covered:
- The jet propulsion principle. Types of Engines. Performance parameters.
- Ramjets.
- Turbojets.
- Turbofans.
- Turboprops and Turboshafts.
- Inlets, Combustors, and Nozzles.
- Compressors and Turbines
- Rockets
- Hypersonic propulsion
The final course grade, based on

HW: Weekly homework assignments (7 total)
MT1: 1st midterm exam: First day week 6 (2/12/2019)
MT2: 2nd midterm exam: First day week 9 (3/5/2019)
Final exam: 3/21/2019 (place TBA),

is to be computed with the following formula:

Grade=0.1*HW+0.25*MAX(MT1,FINAL) +0.25*MAX(MT2,FINAL)+0.4*FINAL
1. Homework assignments and solutions will available on the class website:
2. All students are expected to adhere to the UCSD Policy on Integrity of Scholarship. You may discuss homework problems, but must prepare and submit homework reports on your own.
3. Homework must be written clearly and neatly. Homework assignments are to be collected on Tuesdays at the end of the lecture. No late homework will be accepted.
4. Graded assignments are to be collected during TA office hours.
5. Questions regarding your grade on the midterms should be addressed to the TA within 48 hours after the grade is released.
6. There will be no make-up exams (midterms or final). If you anticipate that you will not be able to be present for the midterms or the final, you should drop the class and take it at a later date.
7. You are encouraged to ask questions during the lectures.