S.J.C. Institute of Technology

DEPARTMENT OF AERONAUTICAL

SUBJECT: *Elements of aeronautics*

(PROJECT REPORT ON COMPARISION OF "*AERODYNAMIC, PROPULSIVE, PERFORMANCE, STRUCTURAL PARAMETERS WITH DESIGIN*" OF 10 DIFFERENT AIRCRAFTS)

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DIFFERENT TYPES OF AIRCRAFTS WITH ITS SPECIFICATIONS

Subject name: Elements of aeronautics

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1. LCA- Tejas
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TEJAS

• Aerodynamic parameters:

• Propulsive system:

LCA-TEJAS

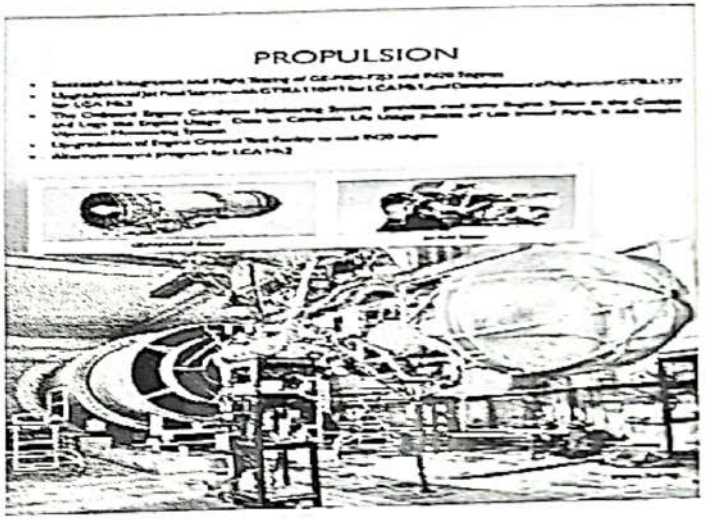
TEJAS is an Indian light combat aircraft (LCA) which is designed by ADA with HAL as its principal partner along with DRDO, CSIR, BEL, DGAQA, IAF and IN.

Tejas is a single engine, light weight, highly agile, multi-role supersonic fighter. It has quadruplex digital fly-by-wire Flight Control System (FCS) with associated advance flight control laws. The aircraft with delta wing is designed for 'air combat' and 'offensive air support' with 'reconnaissance' and 'anti-ship' as its secondary role. Extensive use of advance composites in the aircraft gives a high strength to weight ratio, long fatigue life and low radar signatures. Aeronautical Development Agency is designated project manager for the development of LCA.

The complex geo -graphical nature of South Asia and its surroundings has resulted in major conflicts in the region in the past. From the very beginning after the birth of nation, India has faced serious military threats. History taught us that there is compulsion to achieve self-reliance in design, development and production of critical weapon system to guard the sovereignty of our country.

LCA programme was launched in the early eighties for two primary purposes. The principal and most obvious goal were the development of a replacement aircraft for India's ageing MiG- 21 fighters. The MiG-21 has been the military of Indian Air Force since 1970's. The other main objective was to give an impetus for an across-the -board advancement of India's domestic aviation capability.

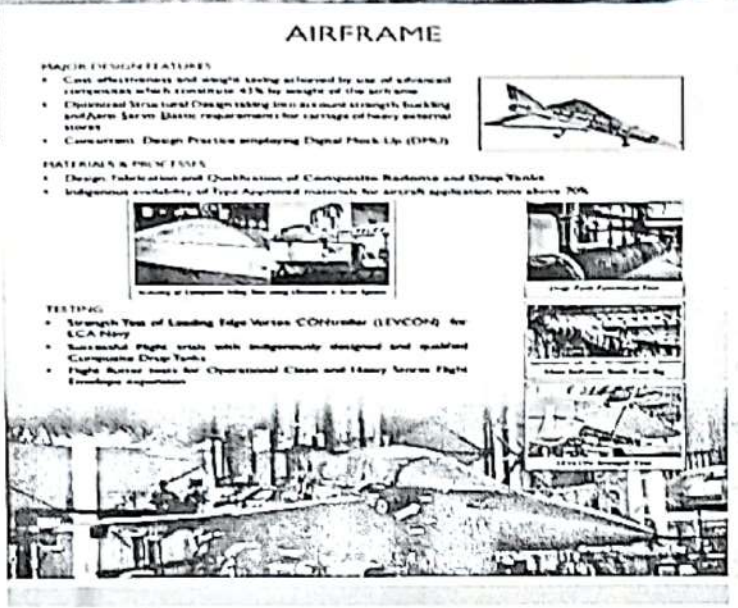
The TEJAS employs CFC materials for up to 45% of its airframe including in the fuselage, wings, elevons, tail fin, rudder, airbrakes and landing gear doors. Apart from making the plane much lighter using CFC's, there are also fewer joints or rivets which increases the aircrafts reliability lowers its susceptibility to structural fatigue cracks. The use of composites in LCA resulted in 40% reduction in total number of parts compared to using metallic frames. Overall the aircrafts weight is reduced by 20%.



AERODYNAMICS AND PERFORMANCE

Tejas is a highly maneuverable and agile combat aircraft designed for air defence and offensive roles. It features aerodynamically unstable tailless compound delta wing configuration which is culmination of an intense design exercise involving extensive Computational Fluid Dynamics studies and Wind Tunnel testing. An additional control surface, Leading Edge Vortex CONtroller (LEVCON) is incorporated in LCA Navy to enable operations from a carrier.

• Aircraft structures and materials:



LCA-TEJAS SPECIFICATION

Role: Multirole fighter

National origin: India

Manufacturer: Hindustan Aeronautics Limited (HAL)

Design group: Aeronautical Development Agency

First flight: 4th Jan 2001

Introduction: 17th Jan 2015

Status: In production

Primary users: Indian Air Force and Indian Naval Air Army

Number built: SP-16(16)till date

STRUCTURE

Fuselage structure:

Fuselage is the main body of the aircraft, and it is the structure where all the other parts like engine, wing, tail, fin and landing gear are coupled to form an aircraft. The LCA is the semi-monocoque structure consisting of bulkheads, floor, side, walls, longerous and stringers with skins.

The fuselage of TEJAS aircraft comprises of 38 stations for the easy of manufacturing and its structure is designed in order to provide minimum weight structure, maximum internal space, better strength and coupling capabilities.

There exists four longerons which supports the structure horizontally and the shear walls are presented adjacent to longerous, in between the bulkheads.

1.Front fuselage:

FF consists of stations from 1 to 21 during its assembly. It comprises of cockpit bay, FIA fuel tank, electrical system bay, MMR bay, avionics bay, ECS bay, nose landing gear with its undercarriage and avionics system bay. There are 21 of which 4 main bulkheads present are at #4, #13, #15, #19; these bulkheads are the largest part in the fuselage.

2.Centre fuselage:

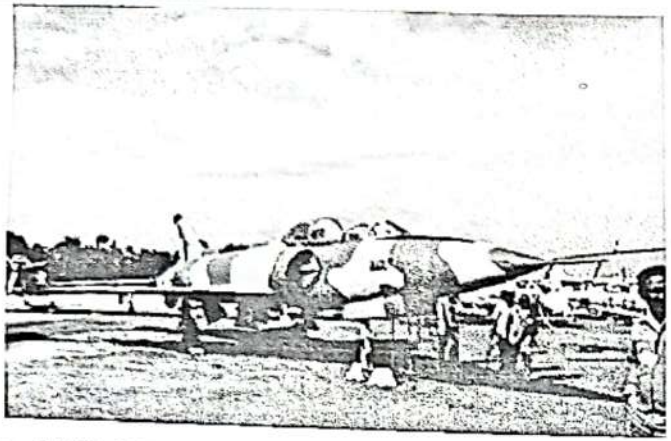
CF consists of stations from #21 to #30 during its assembly. This section fuselage is the most important as it holds fuselage fuel tanks, with main landing gear, wing pickup points, air duct assembly and undercarriage. It is heavily strengthened as majority of the planes load falls in this section of fuselage.

3. Rear fuselage:

CF consists of stations from 21 to 30 during its assembly. There is only one bulkhead at station 30 for coupling with CF, 8 frames with stringers. It is also crucial section in the fuselage as it holds the propulsion system and vertical fin, it also makes place for airbrake and landing parachute and tail cone assembly.

There are three main engine points which holds the engine intact with aircraft at station 31 to 36 on port side there exists a fixed point and on starboard side there exists a moveable point.

HF-24 MARUT



The **HAL HF-24 Marut** ("Spirit of the Tempest") is an Indian fighter-bomber aircraft of the 1960s. Developed by Hindustan Aircraft Limited (HAL), with Kurt Tank as lead designer. It is the first Indian-developed jet aircraft, and the first Asian jet fighter to go beyond the test phase and into successful production and active service. On 17 June 1961, the type conducted its maiden flight; on 1 April 1967, the first production Marut was officially delivered to the IAF.

• Performance parameters:

Performance

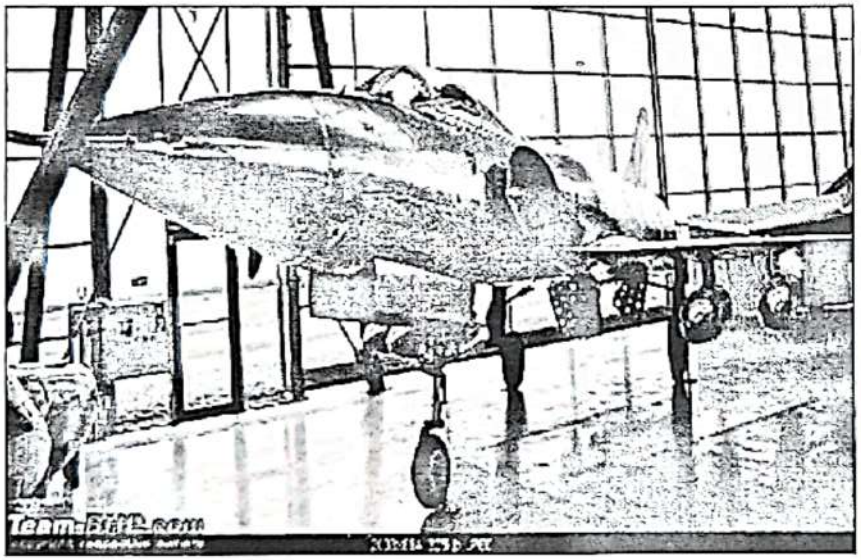
- **Maximum speed:** 1,112 km/h (691 mph, 600 kn) at sea level
- **Maximum speed:** Mach 0.93
- **Stall speed:** 248 km/h (154 mph, 134 kn) (flaps and landing gear down)
- **Combat range:** 396 km (246 mi, 214 nmi) [1]
- **Time to altitude:** 9 min 20 s to 12,000 m (40,000 ft)

Armament

- **Guns:** 4× 30 mm (1.18 in) ADEN cannon with 120 rpg
- **Rockets:** Retractable Matra pack of 50× 2.68 in (68 mm) rockets
- **Bombs:** Up to 4,000 lb (1,800 kg) on four wing pylons

- **Crew:** 1
- **Length:** 15.87 m (52 ft 1 in)
- **Wingspan:** 9.00 m (29 ft 6 in)
- **Height:** 3.60 m (11 ft 10 in)
- **Wing area:** 28.00 m^2 (301.4 sq ft)
- **Aspect ratio:** 2.90:1
- **Empty weight:** 6,195 kg (13,658 lb)
- **Fuel capacity:** 2,491 L (658 US gal; 548 imp gal) usable internal fuel
- **Powerplant:** 2 × Bristol Siddeley Orpheus Mk 703 turbojets, 21.6 *kN (4,900 lbf) thrust each*

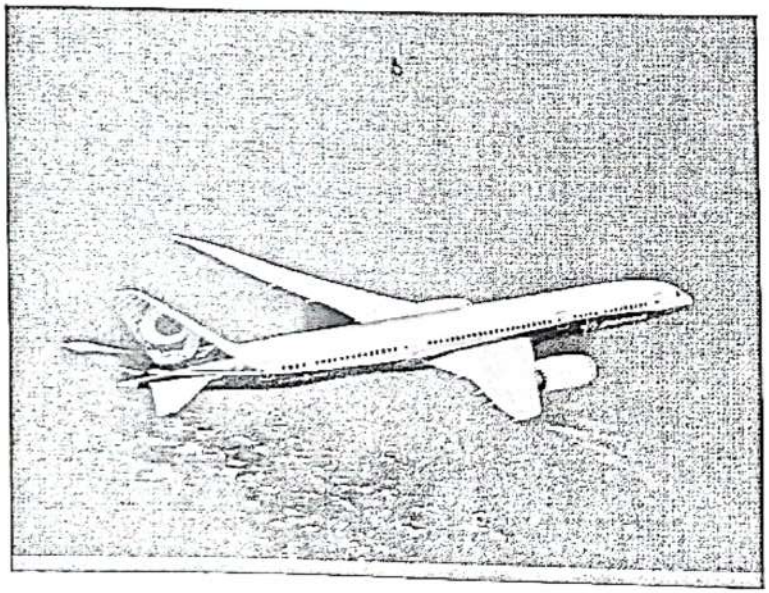
• Aerodynamic structures and materials:



1. Marut 'streamlined, aerodynamically Clean pencil fuselage with its side air in take for the twin power plants
2. Thin wing designed for super sonic flight
3. Under the wings we see 2 Weapons pylonS of the port (left) wing
4. Wide track under Carriage to support landings on rough airfields
5. The bubble canopy for good visibility, and
6. The fairings, under the nose for the four 30mm Aden cannons each fairing 10 rounds per second.

BOEING 787

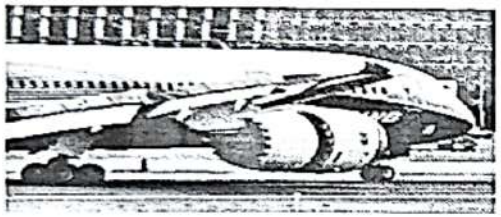
- Aerodynamic structures and materials:



The **Boeing 787** aircraft is 80% **composite** by volume. By weight, the **material** contents is 50% **composite**, 20% aluminum, 15% titanium, 10% steel, and 5% other [11]. Aluminum is used for the wing and tail leading edges; titanium is used mainly on engines and fasteners, with steel used in various areas.

• Propulsive system

ENGINE



The chevron-toothed exhaust duct covers on the first 787, shown here with thrust-reversers deployed

The 787 is powered by two engines; these engines use all-electrical bleedless systems, eliminating the superheated air conduits normally used for aircraft power, de-icing, and other functions.[6] As part of its "Quiet Technology Demonstrator 2" project, Boeing adopted several engine noise-reducing technologies for the 787. These include an air inlet containing sound-absorbing materials and exhaust duct cover with a chevron-toothed pattern on the rim for a quieter mixing of exhaust and outside air.[189] Boeing expects these developments to make the 787 significantly quieter both inside and out.[227]

• Performance parameters:

SEATING

787-8
242

787-9
290
+20% vs. 787-8

787-10
330
+36% vs. 787-8
+14% vs. 787-9

RANGE

787-8
7,355 nmi (13,620 km)

787-9
7,635 nmi (14,140 km)

787-10
6,430 nmi (11,910 km)

WINGSPAN

787-8
197 ft (60 m)

787-9
197 ft (60 m)

787-10
197 ft (60 m)

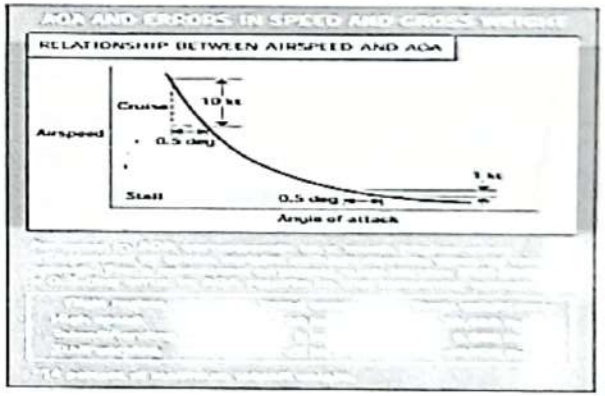
LENGTH

787-8
186 ft (57 m)

787-9
206 ft (63 m)

787-10
224 ft (68 m)

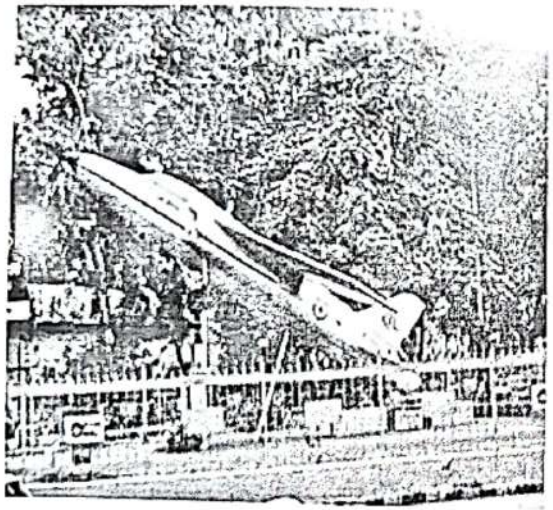
• Aerodynamic parameters



AJEET

• Design of Ajeet aircraft

Ajeet



The prototype Ajeet, E1083, preserved outside HAL's headquarters in Bangalore

Role	Fighter

AJEET

- Single Seat AIR combat and short range ground attack fighter
- Accommodates fuel internally in integral fuel tanks in the centre and has improved systems.
- Light weight jet fighter aircraft
- Improved version commenced 1972 and completed by end 1980.

In the design phase of the Ajeet, HAL redesigned several aspects of the aircraft while seeking to improve both the reliability and effectiveness of several subsystems, such as the avionics and hydraulic systems. The adoption of a wet wing expanded the fighter's internal fuel capacity and freed-up several underwing hardpoints for other purposes, effectively increasing both the range and payload capability of the aircraft. On 6 March 1975, the first of two Ajeet prototypes, producing via the conversion of the final two licence-produced Gnat fighters, conducted its maiden flight. The satisfactory performance of these prototypes contributed to the issuing of a production order for the Ajeet. On 30 September 1976, the first production aircraft performed its maiden flight.[1] Introduced to service during the following year, the Ajeet had a relatively brief and unremarkable service life, equipping only a single IAF squadron and being withdrawn from service during 1991.

Propulsive parameters

Turbojet engines are used in Ajeet aircraft .It consists of turbine with Propelling nozzel

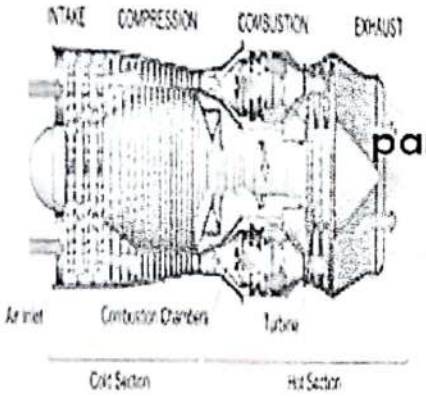


Diagram of a typical gas turbine jet engine

parameter

Performance

- **Maximum speed:** 1,152 km/h (622 knots, 716 mph) at sea level
- **Combat radius:** 172 km (93 nmi, 107 mi) low level, with two 250 kg bombs
- **Service ceiling:** 45,000 ft (13,720 m)
- **Wing loading:** lb/ft^2 (kg/m^2)
- **Climb to 12,000 m (39,375 ft):** 6 min 2 s

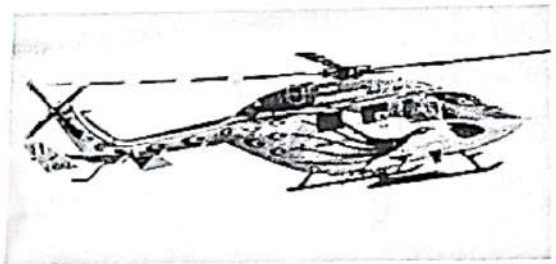
Armament

- **Guns:** 2 × 30 mm ADEN cannons with 90 rounds each
- **Bombs:** Up to 1,985 lb (900 kg) of external stores on four underwing hardpoints

The **turbojet** is an airbreathing jet engine, typically used in aircraft. It consists of a gas turbine with a propelling nozzle. The gas turbine has an air inlet, a compressor, a combustion chamber, and a turbine (that drives the compressor). The compressed air from the compressor is heated by the fuel in the combustion chamber and then allowed to expand through the turbine. The turbine exhaust is then expanded in the propelling nozzle where it is accelerated to high speed to provide thrust.[1] Two engineers, Frank Whittle in the United Kingdom and Hans von Ohain in Germany, developed the concept independently into practical engines during the late 1930s.

DRUV HELICOPTER

Dhruv



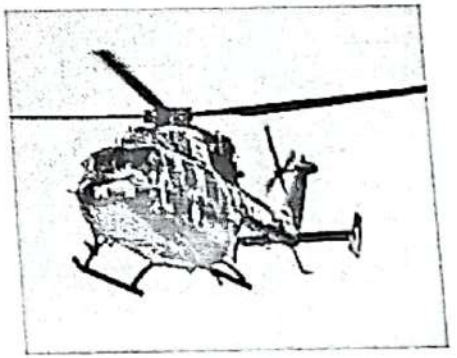
Dhruv helicopter of the Indian Air Forces, Sarang Helicopter Display Team in 2008 at RAF Fairford.

Role	Multirole helicopter

The **HAL Dhruv** is a utility helicopter developed and manufactured by India's Hindustan Aeronautics Limited (HAL). The development of the Dhruv was first announced in November 1984, and it was subsequently designed with assistance from MBB in Germany. The helicopter first flew in 1992; however, its development was prolonged due to multiple factors including the Indian Army's requirement for design changes, budget restrictions, and sanctions placed on India following the 1998 Pokhran-II nuclear tests.

The cockpit section of the fuselage is of Kevlar and carbon-fibre construction; it is also fitted with crumple zones and crashworthy seats. The aircraft is equipped with a SFIM Inc four-axis automatic flight control system. Avionics systems include a HF/UHF communications radio, IFF recognition, Doppler navigation, and a radio altimeter; a weather radar and the Omega navigation system were options for the naval variant.[34] IAI has also developed targeting systems and an electronic warfare suite for the Dhruv, as well as avionics for day-and-night flight observation.[26] HAL's claim that the Dhruv is indigenous has been challenged by Comptroller and Auditor General of India, who reported that as of August 2010 the helicopter was: "...against the envisaged indigenisation level of 50% (by 2008), 90% of the value of material used in each ALH is still imported from foreign suppliers".[35]

• Aerodynamic structure And materials used:



An Indian Army Dhruv at ILA 2008

The HAL Dhruv is of conventional design; about 29 percent of its empty weight (constituting 60 percent of the airframe's surface area) is composite materials.[31] It has been reported that the unique carbon fibre composite developed by HAL reduced the helicopter's weight by 50 percent.[32] The high

• Performance parameters:

Performance

- **Never exceed speed:** 245 km/h (152 mph, 132 kn) for Mk IV
- **Range:** 590 km (370 mi, 320 nmi) for Mk IV
- **Endurance:** 3.8 hours
- **Service ceiling:** 6,100 m (20,000 ft) [16]
- **Rate of climb:** 10.33 m/s (2,033 ft/min)
- **Disk loading:** 40.19 kg/m² (8.23 lb/sq ft)

Armament

- 1 × 20mm M621 cannon on Nexter THL-20 chin-mounted gun turret
- 1 × 7.62 mm cabin-mounted machine gun (coast guard version)
- 2×2 MBDA Mistral-1 short-range air-to-air missiles
- 4 × 70 mmThales 12-round rocket pods[17]
- 4×2 Helina anti-tank guided missiles (in development)

- **Crew:** Two pilots
- **Capacity:** 12 passengers (14 passengers in high density seating)
- **Length:** 15.87 m (52 ft 1 in)
- **Width:** 3.15 m (10 ft 4 in)
- **Height:** 4.98 m (16 ft 4 in)
- **Gross weight:** 4,445 kg (9,800 lb)

• Propulsive system:

- There are different types of engines used for different types of druv helicopters one among them is:-**Shakthi engine**

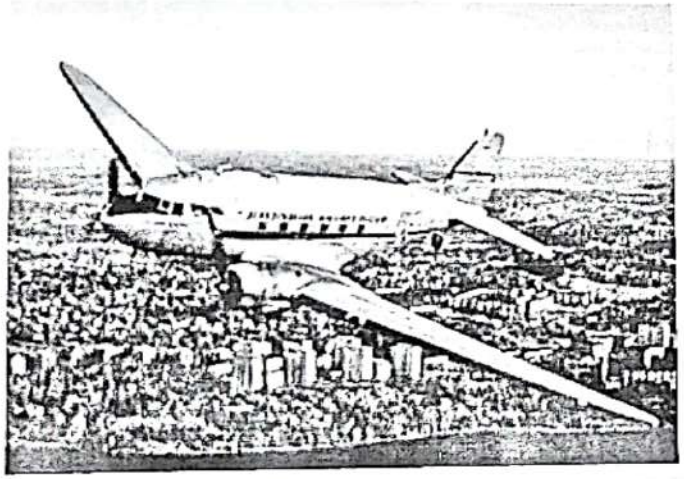
Shakti Engine (For Dhruv Mk-III & Mk-IV)

- 12 % Higher power than TM 333 2B2 engine
- Dual centrifugal compressor assembly
- Single crystal blades
- Dual channel FADEC

DOUGLAS DC-3

• Design and material composition:

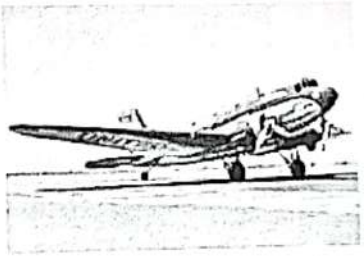
DC-3



The DC-3 is a low wing airliner powered by two radial engines

Role	Airliner and transport aircraft

DC-3 airliner cabin

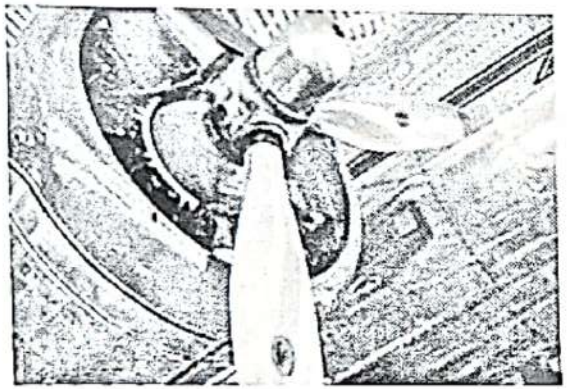


A Douglas Sleeper Transport (DST). DSTs were built with a second row of windows for the upper bunk beds, visible above the airline titles

"DC" stands for "Douglas Commercial". The DC-3 was the culmination of a development effort that began after an inquiry from Transcontinental and Western Airlines (TWA) to Donald Douglas. TWA's rival in transcontinental air service, United Airlines, was starting service with the Boeing 247 and Boeing refused to sell any 247s to other airlines until United's order for 60 aircraft had been filled.[6] TWA asked Douglas to design and build an aircraft that would allow TWA to compete with United. Douglas' design, the 1933 DC-1, was promising, and led to the DC-2 in 1934. The DC-2 was a success, but there was room for improvement.

Propulsive system of DC -3

•Cyclone 9 engine:



A variety of radial engines were available for the DC-3. Early-production civilian aircraft used either the nine-cylinder Wright R-1820 Cyclone 9 or the fourteen-cylinder Pratt & Whitney R-1830 Twin Wasp, but the Twin Wasp was chosen for most military versions and was also used by most DC-3s converted from military service. Five DC-3S *Super DC-3s* with Pratt & Whitney R-2000 Twin Wasps were built in the late 1940s, three of which entered airline service.

Structural parameters:

- **Crew:** two
- **Capacity:** 21–32 passengers
- **Length:** 64 ft 8 in (19.7 m)
- **Wingspan:** 95 ft 2 in (29.0 m)
- **Height:** 16 ft 11 in (5.16 m)
- **Wing area:** 987 sq ft (91.7 m^2)
- **Aspect ratio:** 9.17
- **Airfoil:** NACA2215 / NACA2206
- **Empty weight:** 16,865 lb (7,650 kg)
- **Gross weight:** 25,200 lb (11,431 kg)
- **Fuel capacity:** 822 gal. (3736 l)
- **Powerplant:** 2 × Pratt & Whitney R-1830-S1C3G Twin Wasp 14-cyl. air-cooled two row radial piston engine, 1,200 hp (890 kW) each
- **Propellers:** 3-bladed Hamilton Standard 23E50 series, 11 ft 6 in (3.5 m) diameter

• Performance parameters

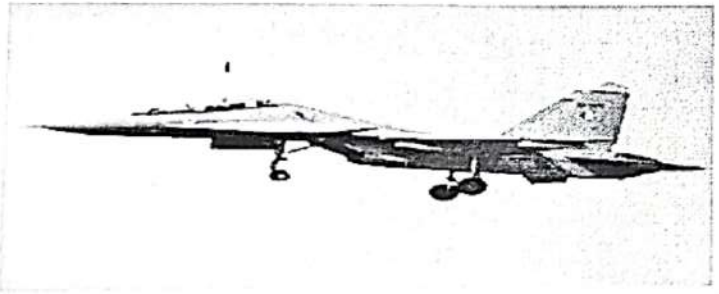
Performance

- **Maximum speed:** 200 kn (230 mph, 370 km/h) at 8,500 ft (2,590 m)
- **Cruise speed:** 180 kn (207 mph, 333 km/h)
- **Stall speed:** 68.0 kn (78.2 mph, 125.9 km/h)
- **Service ceiling:** 23,200 ft (7,100 m)
- **Rate of climb:** 1,130 ft/min (5.7 m/s)
- **Wing loading:** 25.5 lb/sq ft (125 kg/m^2)
- **Power/mass:** 0.0952 hp/lb (156.5 W/kg)

SUKHOI SU-30MKI

The **Sukhoi Su-30MKI**[a] (NATO reporting name: **Flanker-H**) is a twinjet multirole air superiority fighter developed by Russia's Sukhoi and built under licence by India's Hindustan Aeronautics Limited (HAL) for the Indian Air Force (IAF). A variant of the Sukhoi Su-30, it is a heavy, all-weather, long-range fighter.

Su-30MKI



An Indian Air Force Su-30MKI

Role	Multirole air superiority fighter

Aircraft structure and materials

The Su-30MKI is a highly integrated twin-finned aircraft. The airframe is constructed of titanium and high-strength aluminium alloys. The engine intake ramps and nacelles are fitted with trouser fairings to provide a continuous streamlined profile between the nacelles and the tail beams. The fins and horizontal tail consoles are attached to tail beams. The central beam section between the engine nacelles consists of the equipment compartment, fuel tank and the brake parachute container. The fuselage head is of semi-monocoque construction and includes the cockpit, radar compartments and the avionics bay.

• Propulsive system

The Su-30MKI is powered by two Lyulka-Saturn AL-31FP turbofans, each rated at 12,500 kgf (27,550 lbf) of full after-burning thrust, which enable speeds of up to Mach 2 in horizontal flight and a rate of climb of 230 m/s. The mean time between overhaul is reportedly 1,000 hours with a full-life span of 3,000 hours; the titanium nozzle has a mean time between overhaul of 500 hours. In early 2015, Defence Minister Manohar Parrikar stated before Parliament that the AL-31FP had suffered numerous failures, between the end of 2012 and early 2015, a total of 69 Su-30MKI engine-related failures had occurred; commons causes were bearing failures due to metal fatigue and low oil pressure, in response several engine modifications were made to improve lubrication, as well as the use of higher quality oil and adjustments to the fitting of bearings.[57]

• Performance parameters

Performance

- **Maximum speed:**
  - **At high altitude:** Mach 2 (2,120 km/h; 1,320 mi)[99]
  - **At low altitude:** Mach 1.09 (1,350 km/h, 839 mph)
- **Range:**
  - **At high altitude:** 3,000 km (1,860 mi; 1,620 nmi)
  - **At low altitude:** 1,270 km (790 mi; 690 mi)
- **Combat radius:** 1,300 km[103] (808 mi)
- **Ferry range:** 8,000 km (4,970 mi; 4,320 nmi) with two in-flight refuellings[100]
- **Service ceiling:** 17,300 m (56,800 ft)
- **Rate of climb:** >300 m/s (>45,275 ft/min)
- **Wing loading:** 401 kg/m^2 (82.3 lb/ft^2)
- **Thrust/weight:** 0.96
- **Maximum *g*-load:** +9 g

• Aerodynamic parameters

Su-30MKI aerodynamic configuration is a longitudinal triplane with relaxed stability. The canard increases the aircraft lift ability and deflects automatically to allow high angle of attack (AoA) flights allowing it to perform Pugachev's Cobra. The integral aerodynamic configuration combined with thrust vectoring results in extremely capable manoeuvrability, taking off and landing characteristics. This high agility allows rapid deployment of weapons in any direction as desired by the crew. The canard notably assists in controlling the aircraft at large angles-of-attack and bringing it to a level flight condition. The aircraft has a fly-by-wire (FBW) with quadruple redundancy. Dependent on flight conditions, signals from the control stick position transmitter or the FCS may be coupled to remote control amplifiers and combined with feedback signals from acceleration sensors and rate gyros. The resultant control signals are coupled to the high-speed electro-hydraulic actuators of the elevators, rudders

• Structural parameters

BrahMos missile under Su-30MKI mock-up at MAKS-2009

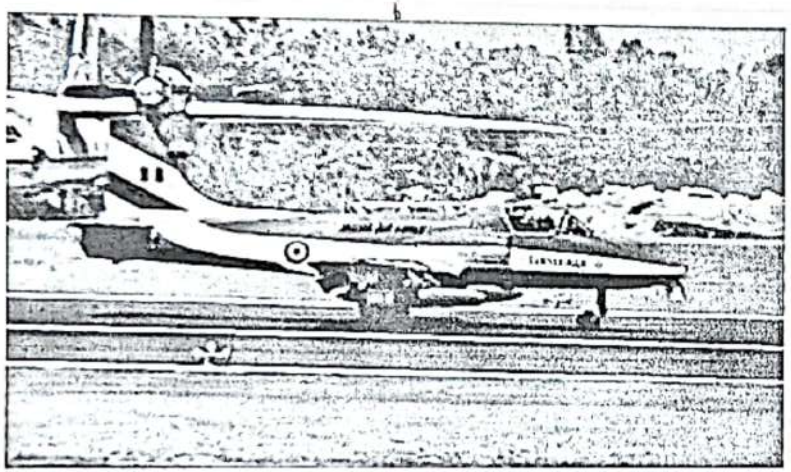
- **Crew:** 2
- **Length:** 21.935 m (73 ft)
- **Wingspan:** 14.7 m (48 ft 3 in)
- **Height:** 6.36 m (20 ft 10 in)
- **Wing area:** 62 m^2 (667 ft^2)
- **Empty weight:** 18,400 kg[102] (40,565 lb)
- **Loaded weight:** 26,090 kg (57,520 lb) (typical mission weight)[99]
- **Max. takeoff weight:** 38,800 kg (85,600 lb)
- **Powerplant:** 2 × Lyulka AL-31FP turbofans, 123 kN (27,560 lbf) each

and the canard. The output signals are compared and, if the difference is significant, the faulty channel is disconnected. FBW is based on a stall warning and barrier mechanism which prevents stalls through dramatic increases of control stick pressure, allowing a pilot to effectively control the aircraft without exceeding the angle of attack and acceleration limitations. Although the maximum angle of attack is limited by the canards, the FBW acts as an additional safety mechanism.

The Su-30MKI has a range of 3,000 km with internal fuel which ensures a 3.75 hour combat mission. Also, it has an in-flight refueling (IFR) probe that retracts beside the cockpit during normal operation. The air refueling system increases the flight duration up to 10 hours with a range of 8,000 km at a cruise height of 11 to 13 km.[*citation needed*] Su-30MKIs can also use the Cobham 754 buddy refueling pods.[48][49]

HJT 16-KIRAN

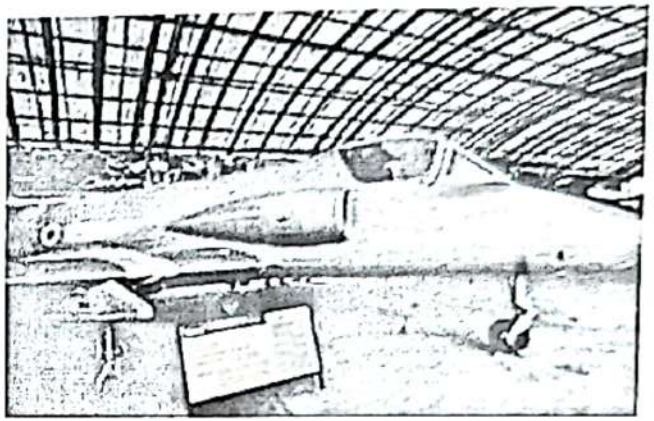
HJT-16 Kiran



A HAL Kiran Mk II of the Surya Kiran at the runway of the Yelahanka Air Force Base.

Role	Intermediate jet trainer

Aerodynamic structure and materials:



A *Kiran II* on static display at the HAL Museum, Bangalore, 2011

The Kiran was developed by Indian aircraft manufacturer Hindustan Aeronautics Limited (HAL) in response the issuing of an Indian Air Force (IAF) requirement that called for a new intermediate jet-powered trainer aircraft.

• Performance parameters

- **Maximum speed:** 695 km/h (432 mph, 375 kn) at sea level
- **Cruise speed:** 324 km/h (201 mph, 175 kn)
- **Stall speed:** 137–145 km/h (85–90 mph, 74–78 kn) flaps extended and landing gear deployed
- **Endurance:** 1 hr 45 min
- **Service ceiling:** 9,150 m (30,020 ft)
- **Time to altitude:** 20 min to 9,150 m (30,000 ft)

- **Crew:** 2
- **Length:** 10.60 m (34 ft 9 in)
- **Wingspan:** 10.70 m (35 ft 1 in)
- **Height:** 3.64 m (11 ft 11 in)
- **Wing area:** 19.00 m^2 (204.5 sq ft)
- **Aspect ratio:** 6.03:1
- **Airfoil:** NACA 23015 at root, NACA 23012 at tip
- **Empty weight:** 2,560 kg (5,644 lb)
- **Max takeoff weight:** 4,235 kg (9,337 lb)
- **Fuel capacity:** 1,137 L (300 US gal; 250 imp gal) internal fuel

• Propulsion

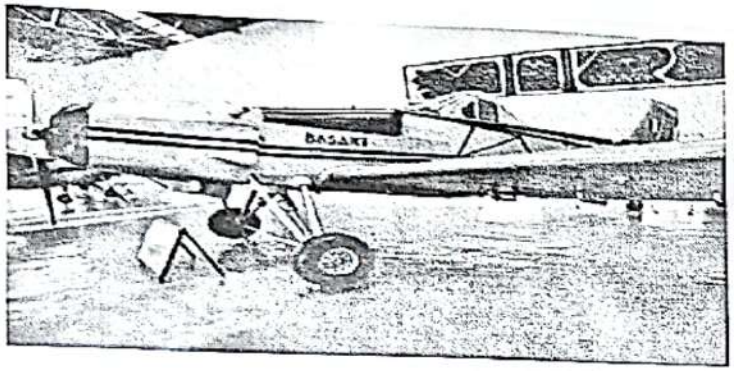
Kiran Mk II

Improved version with four hardpoints and integral twin 7.62 mm machine guns in nose and a Bristol Siddeley Orpheus engine.[4] 61 built.[6]

During the 1970s, work was undertaken by HAL on an uprated version of the **aircraft**; it was instead powered by the Bristol Siddeley Orpheus turbojet **engine**, capable of generating a maximum thrust of 4,200 lbf (19,000 N).

BASANT

HA-31 Basant



Role

Agricultural/utility aircraft

•Meterial composition and aircraft structure

Hindustan Aeronautics started to design an agricultural aircraft in 1968 designated the **HAL-31 Mk 1** with a cockpit directly over the wing leading edge. It was re-designed as the **HA-31 Mk II Basant** and first flew on the 30 March 1972. The Basant is a conventional braced low-wing monoplane with a fixed tailwheel landing gear and powered by a 400 hp (298 kW) Avco Lycoming IO-720 piston engine. It had a raised cockpit to give the pilot a good all-round view during spraying operations. Production ended in 1980 after 39 aircraft had been built.

performance parameters

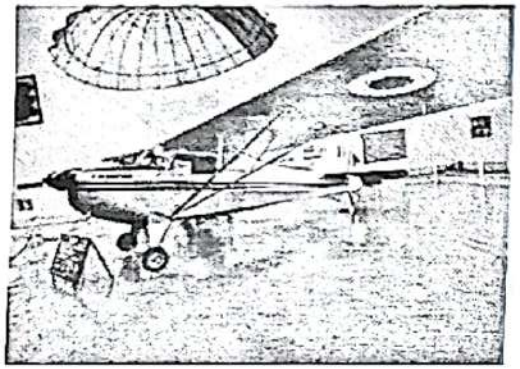
- **Maximum speed:** 140 mph (225 [1] km/h)
- **Cruise speed:** 115 mph (185 km/h)
- **Range:** 400 miles (645[1] km)
- **Service ceiling:** 12,500 ft (3,800[1] m)
- **Rate of climb:** 750 ft/min (3.8[1] m/s)

•Structural parameters

- **Crew:** One
- **Length:** 29 ft 6¼ in (9 m)
- **Wingspan:** 39 ft 4½ in (12 m)
- **Height:** 8 ft 4½ in (2.55 m)
- **Wing area:** 251.23 ft^2 (23.34 m^2)

PUSHPAK

HUL-26 Pushpak



• Construction and material composition

The Pushpak was a high-wing braced monoplane with a fixed tailwheel landing gear.[1] The fuselage was built from metal tubing, the wing aluminum ribs on a wooden spar, all covered in fabric.[1] The *Pushpak* first flew on 28 September 1958 and was powered by a 90 hp (67 kW) Continental flat-four engine.[1]

• Performance parameters

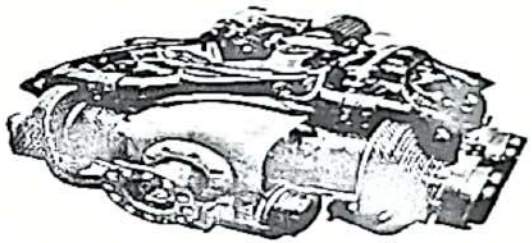
All these range of values makes the aircraft to fly smooth also help in smooth takeoff and landing

- **Maximum speed:** 144 km/h (89 mph, 78 kn)
- **Cruise speed:** 112 km/h (70 mph, 60 kn)
- **Range:** 400 km (250 mi, 220 nmi)
- **Endurance:** 3 hr
- **Service ceiling:** 4,270 m (14,010 ft)
- **Rate of climb:** 2.5 m/s (500 ft/min)

- **Structural parameters:** these parameters will keep the aircraft in equilibrium position and also balance the body even during high velocity of wind

- **Crew:** 2
- **Length:** 6.40 m (21 ft 0 in)
- **Wingspan:** 10.97 m (36 ft 0 in)
- **Height:** 2.77 m (9 ft 1 in)
- **Wing area:** 16.2 m^2 (174 sq ft)
- **Empty weight:** 395 kg (871 lb)
- **Max takeoff weight:** 613 kg (1,351 lb)
- **Fuel capacity:** 56 L (12 imp gal; 15 US gal)
- **Powerplant:** 1 × Continental C90-8F air-cooled flat-four, 67 kW (90 hp)

- **Propulsion**
- **Cotinential flat four engine:** is used in pushpak aircraft



2007 ULPower UL260i aircraft engine

A **flat-four engine**, also known as a **horizontally opposed-four engine**, is a four-cylinder piston engine with two banks of cylinders lying on opposite sides of a common crankshaft. The most common type of flat-four engine is the **boxer-four engine**, each pair of opposed cylinders moves inwards and outwards at the same time.