JD/JW

NATIONAL CADET CORPS

UNITY & DISCIPLINE

CADET'S HAND BOOK (AIR FORCE)

SPECIALISED SUBJECT

Preface

1. National Cadet Corps (NCC), came into existence, on 15 July 1948 under an Act of Parliament. Over the years, NCC has spread its activities and values, across the length and breadth of the country; in schools and colleges, in almost all the districts of India. It has attracted millions of young boys and girls, to the very ethos espoused by its motto, “unity and discipline” and molded them into disciplined and responsible citizens of the country. NCC has attained an enviable brand value for itself, in the Young India’s mind space.

2. National Cadet Corps (NCC), aims at character building and leadership, in all walks of life and promotes the spirit of patriotism and National Integration amongst the youth of the country. Towards this end, it runs a multifaceted training; varied in content, style and processes, with added emphasis on practical training, outdoor training and training as a community.

3. With the dawn of Third Millennia, there have been rapid strides in technology, information, social and economic fields, bringing in a paradigm shift in learning field too; NCC being no exception. A need was felt to change with times. NCC has introduced its New Training Philosophy, catering to all the new changes and developments, taking place in the Indian Society. It has streamlined and completely overhauled its training philosophy, objectives, syllabus, methodology etc, thus making it in sync with times. Subjects like National Integration, Personality Development and Life Skills, Social Service and Community Development activities etc, have been given prominent thrust.

4. The new syllabus, has been crystallised after obtaining a detailed feedback, from all the Directorates and the same having been brainstormed at HQ DG NCC. The syllabus has been implemented with effect from 01 May 2019.

5. For the ease of Trainees, a summary has been given at the end of each chapter. The syllabus has been revised, to make it cadet friendly, by removing the commonalities in subjects, of the school/college syllabus and making it more relevant. It is hoped, that this will facilitate, better assimilation and increased interest among the cadets.

6. The book has been the outcome, of sincere devotion and relentless effort of the Study Team ordered by HQ DG NCC. Our sincere gratitude and compliments to them. Any suggestions are welcome for its improvement in the future editions

7. Contents of this hard work, must form the basis of Institutional Training, with explicit commitment.

(Rajeev Chopra)
Lieutenant General
Director General
National Cadet Corps

Acknowledgement

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JD / JW (AF) SPECIALISED SUBJECTS

BLOCK SYLLABUS

S.No	Subject	Periods		
		First Year	Second Year	Total Periods
1.	General Service Knowledge	06	05	11
2.	Air Campaign	03	06	09
3.	Principles of Flight	06	03	09
4.	Air Field Layout	06	06	12
5.	Aero-Modelling	12	09	21
6.	Flying	-	08	08
Total		**33**	**37**	**70**

JD/JW (AF) SPECIALISED SUBJECTS

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CHAPTER 1: ARMED FORCES AND IAF CAPSULE

Introduction

1. Defence Services play a vital role in maintaining sovereignty and territorial integrity of our nation. All elements of national defence and national security strive in achieving the assigned role and task. It is essential that Cadet of NCC understands the basic organisation of our Armed Forces, Police and CAPF.

Armed Forces

ARMY

2. Indian Army is the land-based branch and the President of India is the Supreme Commander. It is headed by The Chief of Army staff (COAS), who is a four-star general. The Chief of Army Staff is responsible for all Army activities and senior officers who assist him are: -

(a) Vice Chief of Army Staff.
(b) Three Deputy Chiefs of Army Staff.
(c) Principle Staff Officers (PSOs).
(d) Heads of Arms and Services.
(e) Field Army (Commands).

Command Headquarters

3. Command Headquarters is commanded by an officer of the rank of 'Lieutenant General', who is known as the Army Commander or General Officer Commanding – in - Chief. The whole country is divided into eight theatre Commands who have subordinate formations under them. These are: -

Command Insignia	Command Name	Headquarters
	Integrated Headquarters of Ministry of Defence (Army)	New Delhi
	Central Command	Lucknow
	Eastern Command	Kolkata
	Northern Command	Udhampur
	Southern Command	Pune
	South Western Command	Jaipur
	Western Command	Chandimandir
	Army Training Command	Shimla
	Andaman & Nicobar Command	Andaman
	Strategic Force Command	New Delhi

NAVY

4. Our country is covered almost from three sides with water with a coastline of approximately over 6000 Km. The sea around India has impact / effect on India's freedom, trade, commerce, and culture. The Indian Navy (Bhartiya Nau Sena) is the naval branch of the Indian Armed Forces. The President of India serves as Supreme Commander of the Indian Navy. The Chief of Naval Staff, usually a four-star officer in the rank of Admiral, commands the navy. The Indian Navy is the seventh largest in the world. The primary objective of the navy is to secure the nation's maritime borders.

Constituents of the Navy

5. As of 2018, the Indian Navy has a strength of 67,228 personnel and a large operational fleet consisting of one aircraft carrier, one amphibious transport dock, eight landing ship tanks, 11 destroyers, 14 frigates, one nuclear-powered attack submarine, one ballistic missile submarine, 13 conventionally-powered attack submarines, 23 corvettes, six mine countermeasure vessels, 29 patrol vessels, four fleet tankers and various other auxiliary vessels.

Organisation and Administration

6. Chief of Naval Staff commands Indian Navy. Integrated Headquarters of the Ministry of Defence (Navy) is located in New Delhi. The Navy is divided into three commands: -

Command	Headquarter
Western Naval Command	Mumbai.
Eastern Naval Command	Vishakhapatnam.
Southern Naval Command	Kochi.

AIR FORCE

7. Indian Air Force is the youngest of the three Services. It is the air arm of the Indian armed forces. It is the world's fourth largest air force in terms of both personnel and aircraft. Its primary responsibility is to secure Indian airspace and to conduct aerial warfare during a conflict It came into existence in the year 1932. Indian Air Force comprises of fighter aircrafts, transporter aircrafts, bombers and helicopters. The President of India serves as Supreme Commander of the IAF.

Air Headquarters

8. Indian Air Force is commanded by Chief of the Air Staff. The staff of Air Headquarters consists of three branches: -

(a) Air Staff branch.
(b) Administrative branch.
(c) Maintenance branch.

Commands

9. The Air Force is organized into seven commands which are controlled by Air HQ. Each Command is placed under the command of an Air Officer Commanding-in-Chief. The Commands are:-

Command	Headquarter
Operational commands	
Central Air Command (CAC)	Allahabad, Uttar Pradesh.
Eastern Air Command (EAC)	Shillong, Meghalaya
Southern Air Command (SAC)	Thiruvananthapuram, Kerala.
South Western Air Command (SWAC)	Gandhinagar, Gujarat.
Western Air Command (WAC)	New Delhi.

Functional Commands	
Training Command (TC)	Bangalore, Karnataka.
Maintenance Command (MC)	Nagpur, Maharashtra.

POLICE ORGANISATIONS & CENTRAL ARMED POLICE FORCES

10. The principal national-level organization concerned with law enforcement is the Ministry of Home Affairs (MHA) with all matters pertaining to the maintenance of public peace and order. In addition to being the cadre controlling authority of the IPS, the Ministry of Home Affairs maintains several agencies and organizations dealing with police and security. Police in the union territories comes directly under MHA. The Home Secretary, an Indian Administrative Service (IAS) officer, acts as the administrative head of Ministry of Home Affairs.

Central Armed Police Forces & Other Police Organisations

11. The Central Armed Police Forces and other policing agencies have many elements and branches to national security. The details are as under:-

(a) Border Security Force.
(b) Central Industrial Security Force.
(c) Central Reserve Police Force.
(d) Indo-Tibetan Border Police.
(e) National Security Guards.
(f) Special Protection Group.
(g) Sashastra Seema Bal (SSB).
(h) Assam Rifles (AR).

12. Central Investigation and Intelligence Institutions of Police Organisations:-

(a) Central Bureau of Investigation.
(b) Indian Income-tax Department.
(c) Directorate of Revenue Intelligence.
(d) Central Economic Intelligence Bureau.
(e) Directorate General of Central Excise Intelligence.
(f) National Investigation Agency.
(g) Narcotics Control Bureau.
(h) Bureau of Police Research and Development (BPRD).
(j) National Crime Records Bureau (NCRB).

13. Central Forensic Institutions of Police Organisations:-

(a) Central Forensic Science Laboratory.
(b) LNJN National Institute of Criminology and Forensic Sciences (LNJN-NICFS).

State Police Organisations

14. The controlling authority of a State Police force is the Department of the Home of the State Government. The additional chief secretary (Home) or Principal Secretary (Home), generally an Indian Administrative Service (IAS) officer, acts as the executive agency of the State Home Department. Each state and union territory of India has a state police force, headed by a director general of police ranked officer.

15. Under the inspector general are a number of police "Ranges" composed of three to six districts, headed by Deputy Inspectors General. District police headquarters are commanded by Superintendents of Police (SP).

16. **Other Elements of State Police & Hierarchy**. Each district is divided into sub-divisions or circles headed by a Deputy Superintendent of police (DSP). Each sub-division is made up of several police stations under the command of an Inspector of police. In rural areas, a Sub-inspector is in-charge of a police station.

BADGES OF RANKS, HONOURS AND AWARDS IN ARMED FORCES, POLICE AND CENTRAL ARMED POLICE FORCES

17. The Indian Armed Forces, Central Armed Police Forces and Police organisations consist of three services, the Indian Army, Indian Navy, and Indian Air Forces, eight Central Armed Police Forces and other Police organisations in our nation. All the services have distinct badges of ranks with different colours which help in identifying soldiers / policemen and their commanders. The ranks of badges are given as per professional competence and length of service in Armed Forces and in other police organisations.

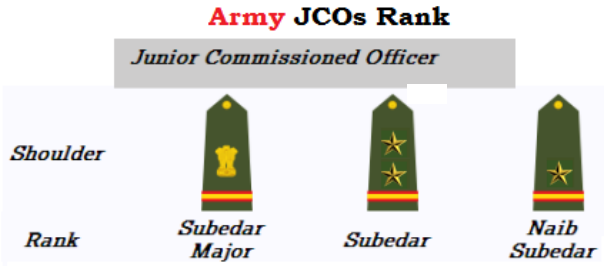
BADGES OF RANK - ARMY

Commissioned Officers - Army

18. Commissioned Officers of Indian Army are those who command their troops from Platoon or equivalent up to armies and hold Presidents commission. Field Marshal is an honorary rank and is given to a General for his valuable services. The badges of rank worn by commissioned officers are as shown:-

Junior Commissioned Officer (JCO) Army

19. The second set of officers in the Army is Junior Commissioned Officers. The soldiers who become JCOs come up through the Non-Commissioned Officer's ranks. The badges of rank worn by the JCOs are as shown:-



Non-Commissioned Officer (NCO) Army

20. The third set of officers is the Non-Commissioned Officers (NCOs). These ranks are given to jawans according to their merit and seniority. The badges of ranks for NCOs are as shown:-

BADGES OF RANK- NAVY

Commissioned Officers Navy

21. Admiral of the Fleet is an honorary rank given to an Admiral for his invaluable services and will continue to serve the rest of his term with the honorary rank. This rank has not been used in the Indian Navy. The badges of rank worn by Naval Officers are: -

Junior Commissioned Officers (JCOs) Navy

22. The badges of rank worn by Junior Commissioned Officers (JCOs) Navy are as shown:-

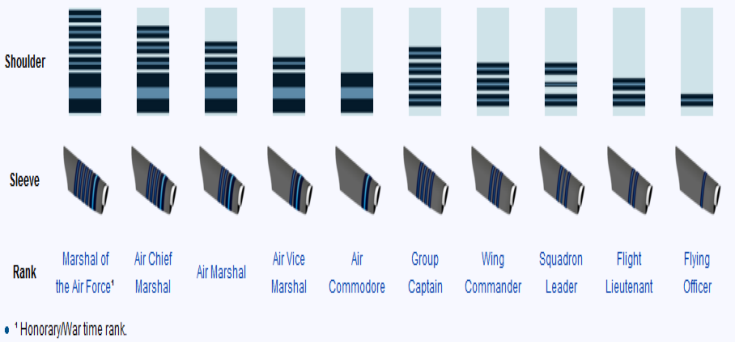
Non-Commissioned Officers (NCOs) Navy

23. The badges of rank worn by the NCOs are as shown:-

BADGES OF RANK- AIR FORCE

Commissioned Officers Air Force

24. Marshall of the Air Force is an honorary rank given to an Air Chief Marshall for his invaluable services. In recognition of his services the Government of India gave the rank of Marshall of the Air Force to Arjan Singh in January 2002 making him the first and the only "Five Star" rank officer with the Indian Air Force. The badges of rank worn by officers are as shown:-



Junior Commissioned Officers (JCOs) Air Force

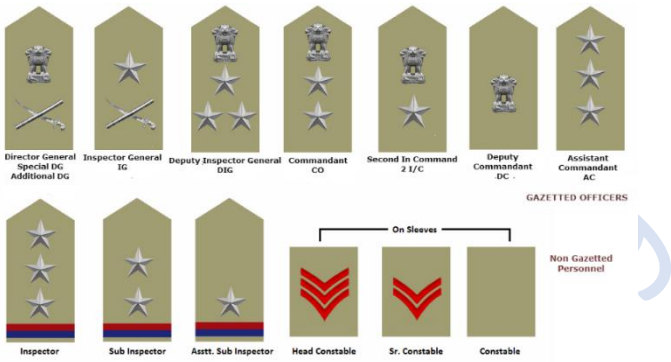
25. The badges of rank worn by these Officers are as shown:-

Non-Commissioned Officers (NCOs) Air Force

26. The badges of rank worn by these NCOs are as shown:-

BADGES OF RANK- POLICE & CENTRAL ARMED POLICE FORCES

27. The badges of ranks worn by CAPF & Police are as shown:-



HONOURS AND AWARDS

28. The Armed Forces, Police and CAPF are also awarded decorations, honours and awards for extraordinary contribution, bravery and courage, as well as for distinguished service during times of war and peace. For the purpose of classification, Civilian's category, Armed Forces, Police and Central Armed Police Forces honours and awards can be divided into following categories: -

(a) Gallantry Awards of Armed forces.
(b) Padma Awards.
(c) President's Police Medal (PPM) for Distinguished Service.
(d) President's Police Medal (PM) for Meritorious Service.
(e) Distinguished Service Awards of Armed Forces.
(f) Governor's Police Medals for Gallantry & Distinguished Service.
(g) Union Home Minister's Medal for Excellence in Investigation.
(h) Antrik Suraksha Seva Medal.
(j) Police Special Duty Medal.
(k) Parakram Padak.
(l) Kabir Puraskar
(m) Communal Harmony Awards
(n) Fire Service Medals
(o) Home Guard & Civil Defence Medals.

29. These awards are given on occasions of various felicitation ceremonies organized at Rashtrapati Bhawan, New Delhi, on Republic Day and on various occasions. The awards given to Armed Forces, CAPF & Police are enumerated below:-

30. **Gallantry Awards in the Face of Enemy (War Time)**.

(a) Param Vir Chakra.
(b) Maha Vir Chakra.
(c) Vir Chakra.
(d) Sena Medal / Nau Sena Medal / Vayu Sena Medal.
(e) Mention in Dispatch.
(f) Chief of Staff Commendation Card.

31. **Gallantry Awards Other than in the Face of Enemy (Peace Time)**.

(a) Ashoka Chakra.
(b) Kirti Chakra.
(c) Shaurya Chakra.
(d) President's Police Medal (PPM) for Gallantry.
(e) President's Police Medal (PPM) for Distinguished Service.

32. **Non-Gallantry Awards /Distinguished Service Awards**.

(a) Sarvottam Yudh Seva Medal.

(b) Param Vishisht Seva Medal.
(c) Uttam Yudh Seva Medal.
(d) Ati Vishisht Seva Medal.
(e) Yuddh Seva Medal.
(f) Vishisht Seva Medal.

ROLE AND TASK OF ARMY, POLICE & CAPF

33. The primary role of the services is to ensure national security and territorial integrity, defending the nation from external aggression and internal threats, and maintaining peace and security within its borders. It conducts humanitarian rescue operations during natural calamities and other disturbances, and also requisitioned by the government to cope with internal threats. In a similar manner primarily central armed police forces and police are meant for national security and for maintenance of public order as well as peace and harmony with in country. During the time of need the Armed Forces are employed in Aid to Civil Authorities if situation is beyond control of CAPF and police forces. The Army since independence has taken part in the following major operations:-

(a) Kashmir Operations against Pakistan 1947-48.
(b) Sino-Indian War in NEFA (Arunachal) and Ladakh 1962.
(c) Indo-Pak war 1965.
(d) Indo-Pak war 1971.
(e) Sri Lanka 1987-1990 (Operation Pawan).
(f) Kargil War 1999 (Operation Vijay).

Command and Control

34. The Integrated Headquarters of Ministry of Defense (Army) functions under the Ministry of Defence and is located at New Delhi. Command HQs have field formations and static formations under them to execute the role and tasks assigned.

Field Formations

35. These are the field forces for the battle, grouped into following three categories:-

(a) **Corps**. Commanded by an officer of the rank of Lieutenant General. It has 3-4 Divisions under its command. The Corps are of two types depending on their role:-
  (i) "Holding" (Defensive) Corps.
  (ii) "Strike" (Offensive) Corps.

(b) **Divisions**. Commanded by an officer of the rank of Major General. It has 3-4 Brigades under its command.

(c) **Brigades**. Commanded by an officer of the rank of Brigadier. It has 3-4 Battalions under its command. Each Battalion has six companies commanded by a Company Commander.

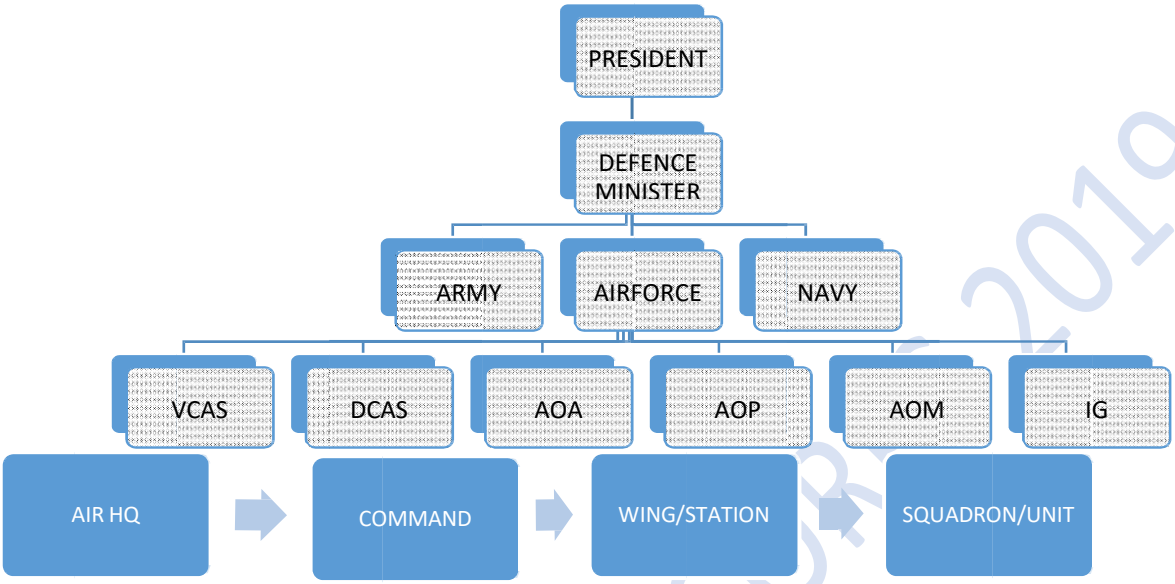
Static Formations

36. Area Headquarters, Sub Area Headquarters and Station Headquarters are commanded by an officer of the rank of Lieutenant General, Major General and Brigadier respectively. These formations are extended all over the country and look after the infrastructural assets, lines of communication logistics, administration and all civil-military matters.

ORGANISATION OF IAF

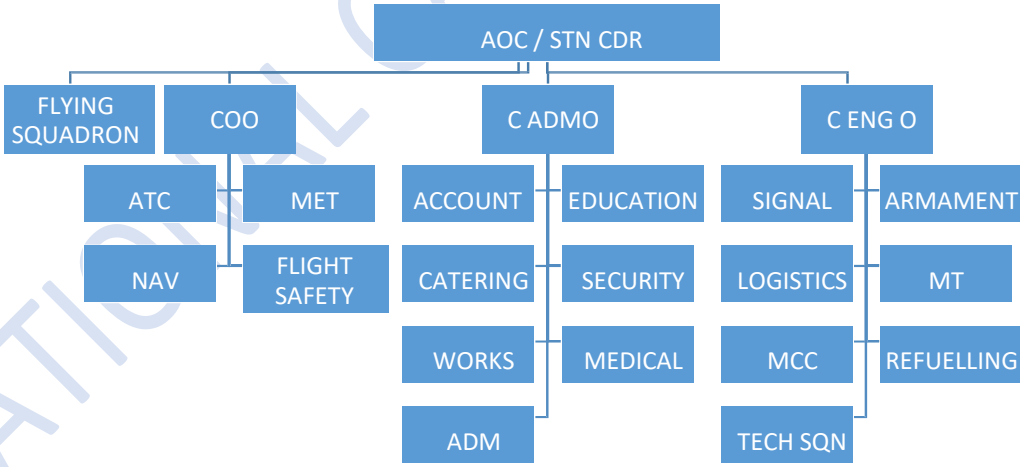
37. The President is the Supreme Commander of the Armed Forces of Indian Republic. The primary role of the Air Force is the air defence of the country, means Guarding of our air space from enemy intrusion

and giving support to the Army and the Navy. Its secondary role is to aid the civil power in maintaining law and order and in providing relief during natural calamities.

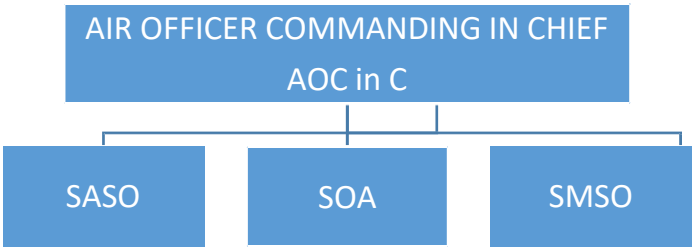


STATION / WING

38. Station/Wing is always what is called a self-accounting unit, ie it is fully capable and independently responsible for its administration. A Sqn / lodger unit is essentially a non-self-accounting unit and it is a lodger to a Wing/Station and depends fully on that Wing/Station for its administration. A Wing/Station exercises its functional and administrative control over its lodger units.



ORGANISATION CHART – OPERATIONAL COMMAND



HISTORY OF IAF

39. The Indian Air Force is the youngest amongst the three services. Even though young it has a bright history. The bravery, valour achievement of the officers and airmen of the IAF are integral Part of its proud heritage.

40. The Government passed the IAF bill on 4 April 1932. The Indian Air Force came into being with the promulgation of the IAF bill on 8 Oct 1932. The governor general -in- council at that time consequently ordered the establishment of Indian Air Force with effect from 8 Oct 1932. The Indian Air force anniversary is celebrated on 8 Oct every year.

GROWTH AND EXPANSION

41. In its early years expansion of IAF was rather slow, In Sep, 1939 it consisted of only one squadron with a complement of 16 officers and 144 airmen. During World War II the increasing commitments of the RAF in Europe and the impact of Japanese invasion in south-east Asia accelerated the pace of progress.

42. The Indian Air Force today is a modern, technology-intensive force distinguished by its commitment to excellence and professionalism. Keeping pace with the demands of contemporary advancement, the IAF continues to modernize in a phased manner and today it stands as a credible air power counted amongst the fore-most professional services in the world.

43. The primacy of Air Power will be a decisive factor in shaping the outcome of future conflicts. In line with this dictum the IAF has developed into a major 'Component of National Power', which can be applied quickly and decisively. The IAF has reoriented itself to a multi-role capability of platforms and equipment, along with multi-skill capability of personnel. The rapid economic growth of the country dictates the need to protect our security interests extending from the Persian Gulf to the Straits of Malacca. Over the years the IAF has grown from a tactical force to one with transoceanic reach. The strategic reach emerges from induction of Force Multipliers like Flight Refueling Aircraft (FRA), Remotely Piloted Aircraft (RPA) and credible strategic lift capabilities. There is emphasis on acquiring best of technology through acquisitions or upgradation, be it aircraft, systems, precision missiles or net centricity.

44. The five operational commands through administrative wings, control some 45 Fixed Wing Squadrons, 20 Helicopters Units and numerous surface to air missile squadrons with unit establishments varying from 12 to 18 aircrafts. This represents a total aircraft strength of 1700 including training and support types, manned by some 170000 personnel.

BRANCHES OF IAF

45. For smooth functioning of an organization different branches amongst staff is essential. Vast organization like Indian Air Force requires various branches to make the organization successful and flawless.

46. Following are the different Branches in the IAF:-

(a) Flying Branch
(b) Navigation Branch
(c) Education Branch
(d) Medical Branch
(e) Administration Branch
(f) Logistic Branch
(g) Meteorology Branch
(h) Engineering Branch

SUMMARY

47. From the raising of Air Force, it has seen various changes and is marching towards the modernization. Since it is the youngest force it has the responsibility of defending the Air territory of our Country. It is the eye in the sky and has the nature of devastating the enemy of the country. From the initial days and having a few personnel IAF now has more than lakh personnel. The true character and strength of IAF was aptly demonstrated in the Balakot Strike and its aftermath.

CHAPTER II : MODES OF ENTRY IN THE IAF & CIVIL AVIATION

1. **Officer Entry**. An officer is a member of an armed force or uniformed service who holds a position of authority. To be able to lead and control, requires the ability to motivate yourself, inspire others and make tough decisions efficiently. Lessons in team work, developing communication skills and confidence, honing strategic and dynamic thinking are grilled into an Officer during his training. The Air Force teaches all, not only making men and women of young boys and girls but making them leaders in life. An officer's strength of character and strong moral compass make him/her stand out from the crowd at all times.

2. Followings are the essential requirements for entry in the IAF to become Commissioned Officer:-

Branch/Type of Entry	Educational Qualification	Age Limit	Advertisement Schedule
Flying Branch			

National Defence Academy (NDA) For Men only	10+2 With Physics & Math	16 1/2 –19	Mar/Oct
Combined Defence Service (CDSE) For Men only	Any Grad. With physics & Math at 10+2 or BE	19-23	Apr/Sep
NCC Special Entry	Any Grad. with Physics & Math at 10+2 or BE&NCC Air Wing Sr Div. "C' Certificate	19-23	Jun/Dec
Short Service Commission (For Women only)	Any Grad. With Physics Maths at10+2 or BE	19-23	Mar/Sep
Technical Branch :(PC For Men/ SCC For Women)			
Aeronautical Engineering (Electronics) Aeronautical Engineering (Mechanical)	First class degree in Engineering or GATE score of 70% & above in Electronics / Mechanical / Allied subjects as per advertisement	18-28	Feb/Aug
Ground Duty Branch : (PC For Men / SCC For Women			
Administration Logistics Accounts	First Class Graduate or PG in subjects as per advertisement	20-23 20-25	Mar/Sep
Education Meteorology	PG in subjects as per advertisement	20-25	Mar/Sep

3. Followings are the essential requirements for entry in the IAF to become Airman**:-**

Group	**Age on Enrolment Date**	**Educational Qualification**
Group 'X' (Technical) Trades	17-22 Years	Passed Intermediate / 10+12 / equivalent examination with Mathematics, Physics and English with a minimum of 50% marks in aggregate. Three years Diploma course in Engineering (Mechanical /Instrumentation Technology/Automobile/Computer Science/Instrumentation Technology/Information Technology) with at least 50% marks in overall aggregate from a Government recognized Polytechnic Institute.
Group 'X' (Education Instructor) Trade	20-25 Years	Graduate in Arts, Commerce or Science with B.Ed degree/two years teaching experience in a Government recognized School/College. Candidate should have scored a minimum of 50% marks in aggregate in Graduation as

		well as B.Ed.
	20-28 Years	Passed MA English/M Sc in Mathematics, Physics, Computer Science/MCA with B Ed degree/2 Years teaching experience in a Government recognized School/College.
Group 'Y' Trades (Except Med Asst and Musician Trade)	17-22 Years	Passed Intermediate /10+2 equivalent with Science, Arts or Commerce subjects or equivalent vocational course with minimum 50% marks in aggregate. Vocational courses should be recognized by Association of Indian Universities.
Group 'Y' (Med Asst)Trade	17-22 Years	Passed Intermediate/10+2/Intermediate /equivalent exam with Physics, Chemistry Biology and English with a minimum of 50% marks in aggregate.
Group 'Y' (Musician Trade)	17-25 years	Passed Matriculation /10th class or equivalent with minimum pass marks from any Government recognized School/Boards and should be proficient in playing at least one of the following musical instrument Trumpet/Bass/Violin/Saxophone/Clarinet/Euphonium /Jazz-Drum /Piccolo/Bass Trombone/Key Board/Guitar/ Sarod /Viola/ Cello/Contra Bass(String Bass).

SUMMARY

12. During the lecture different types of entry have been discussed for entry in the IAF which include the qualifications and advertisement schedule. For more details log on to **www.careerairforce.nic.in**.

CHAPTER III : AIRCRAFT RECOGNITION

1. Aircraft Recognition is essential to identify the aircraft during both in peace and war.

Identification of Aircraft

2. **During Peace Time**. Aircraft recognition helps to identify the different types of aircraft possessed by the enemy and assess the strength of the country and prepare for own self-defense.

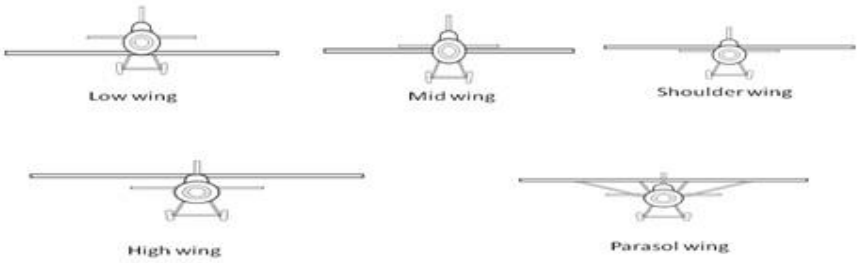
3. **During War Time**. Aircraft recognition helps the MOP (mobile observation post) to identify the Aircraft as friend or foe. It also helps to know the capability of the aircraft by identifying its type.

4. There are various methods used to identify the aircraft:-

(a) Wing position.
(b) Shape of canopy.
(c) Wing shape.
(d) Shape of fins and tail plane(c) Shape of wing tips.
(e) Markings.

5. **Recognition by the Wing Position**.

(a) High wing.
(b) Low mid wing.
(c) Shoulder wing.
(d) Low wing.
(e) Mid wing.
(f) Parasol wing.

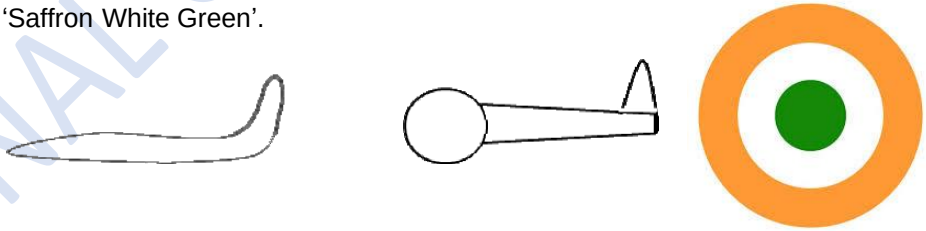


6. **Shape of Canopy**.

(a) Inline.
(b) Submerged.
(c) Teardrop.

(d) Glasshouse.
(e) Bubble.

7. **Markings**. 'Saffron White Green'.



FIGHTER AIRCRAFT

8. **SU-30 MKI**. Twin seater twin engine multirole fighter of Russian origin which carries 30mm GSH gun along with 8000 kg armament. It is capable of carrying a variety of medium-range guided air to air missiles with active or semi-active radar or Infra- red homing close range missiles including nuclear weapons. It has a max speed of 2500 km/hr (Mach 2.35).

9. **MIRAGE-2000**. A single seater air defence and multi- role fighter of French origin powered by a single engine can attain max speed of 2495 km / hr(Mach 2.3). It carries two 30 mm integral cannons and two Matra super 530D medium-range and two R-550 Magic II close combat missiles on external stations.

10. **MiG-29**. Twin engine, single seater air superiority fighter aircraft of Russian origin capable of attaining max speed of 2445 km per hour (Mach-2.3). It carries a 30 mm cannon along with four R-60 close combat and two R-27 R medium range radar guided missiles.

11. **MiG-27**. Single engine, single seater tactical strike fighter aircraft of Russian origin having a max speed of 1700 km / hr (Mach 1.6). It carries one 23 mm six-barrel rotary integral cannon and can carry upto 4000 kg of other armament externally.

12. **MiG-21. BISON**. Single engine, single seater multirole fighter / ground attack aircraft of Russian origin which forms the back-bone of the IAF. It attained instant fame when Wg Cdr Varthaman shot down a superior F-16 aircraft of Pakistan after the Balakot strike. It has a max speed of 2230 km / hr (Mach 2.1) and carries one 23mm twin barrel cannon with four R-60 close combat missiles.

13. **JAGUAR**. A twin-engine, single seater deep penetration strike aircraft of Anglo-French origin which has a max speed of 1350 km / hr (Mach 1.3) It has two 30mm guns and can carry two R-350 Magic missiles

TRANSPORT AIRCRAFT

C-130J. The aircraft is capable of performing para drop, heavy drop, casuality evacuation and can also operate from short and semi prepared surfaces. C-130J is the heaviest aircraft to land at DBO a forward high altitude airfield at Indo China border in Aug 2013.

14. **C-17**. A Strategic Lift aircraft is capable of carrying a payload of 40-70 tons up to a distance of 4200-9000 km in a single hop.

15. **IL-76**. A four engine heavy duty / long haul military transport aircraft of Russian origin with a max speed of 850 km/hr. It has a twin 23 mm cannon in tail turret and capacity to carry 225 paratroopers or 40 tones freight, wheeled or tracked armoured vehicles.

16. **AN-32**. Twin engine turboprop, medium tactical transport aircraft of Russian origin with a crew of four and capacity to carry 39 paratroopers or max load of 6.7 tones.

17. **EMBRAER**. The main role of employment of this executive Jet Air craft is to convey VVIPs/VIPs to destinations within India and abroad. Air HQ Communication Squadron operates this aircraft and it has maintained a flawless incident/accident free track record till date.

18. **AVRO**. Twin engine turboprop, military transport and freighter of British origin having a capacity of 48 paratroopers or 6 tones freight

19. **DORNIER**. Twin engine turboprop, logistic air support staff transport aircraft of German origin capable of carrying 19 passengers or 2057 kg freight.

20. **BOEING 737-200**. Twin engine turbofan, VIP passenger aircraft of American origin with total seating capacity of upto 60 passengers.

HELICOPTERS

21. **MI-25 / MI-35**. Twin engine turboshaft, assault and anti armour helicopter capable of carrying 8 men assault squad with four barrel 12.7 mm rotary gun in nose and upto 1500 Kg of external ordnance including Scorpion anti- tank missiles. It has a max cruise speed of 310 km/hr.

22. **MI-26**. Twin engine turboshaft, military heavy lift helicopter of Russian origin with carrying capacity of 70 combat equipped troops or 20,000 kg payload.

23. **MI-17 V5**. The Mi-17 V5 is a potent helicopter platform, equipped with modern avionics and glass cockpit instrumentation. They are equipped with state-of-art navigational equipment, avionics, weather, radar and are NVG-compatible.

24. **CHETAK**. Single engine turboshaft, light utility French helicopter with capacity of 6 passengers or 500 kg load.

25. **CHEETAH**. Single engine turboshaft, helicopter of French origin having capacity to carry 3 passengers or 1000 kg external sling loads. Cheetah is the life line of the Siachen Glacier dropping load and evacuating soldiers from the highest battlefield in the world.

TRAINING AIRCRAFT

26. **KIRAN**. Indigenous design of HAL. Basic Jet and Armament Trainer. It can carry 2 x 250 kg Bombs or Rocket Pods, 2 x 7.62 mm guns.

27. **HAWK**. Advanced Jet Trainer, can carry ADEN cannon, in centerline pod, Bombs and Missiles.

28. **PILATUS PC-7**. The Pilatus PC-7 Turbo Trainer is a low-wing tandem- seat training aircraft, manufactured by Pilatus Aircraft of Switzerland. The aircraft is capable of all basic training functions including aerobatics, instrument, tactical and night flying.

MADE IN INDIA

29. **LIGHT COMBAT AIRCRAFT (LCA)**. Single seater Multi Role Combat.aircraft It can carry 4000 Kgs (Beyond- Visual-Range missiles, Reconnaissance / Electronic Warfare pods and 23 mm GSH gun. Small size will reduce its chances of detection by enemy radars. It is capable of take-off and landing from very short runways. Inflight refueling probe is for extended range It is world's smallest light weight and highly manoeuverable combat aircraft with seven hard-points. Developed by aeronautical development agency with contribution from more than 100 government/private agencies.

30. **LIGHT COMBAT HELICOPTER (LCH**). The Light Combat Helicopter (LCH) is a multirole combat helicopter being developed in India by Hindustan Aeronautics Limited (HAL) for use by the Indian Air Force and the Indian Army. It can carry guns, rockets, missiles and bombs on 04 Hard points.

31. **Dhruv** Dhruv is a utility helicopter developed and manufactured by India's Hindustan Aeronautics Limited (HAL) It can carry Missiles, Rocket Pods, Torpedoes, Depth charges or Anti-ship missiles. It can carry 12 passengers / 04 patients in stretchers with 02 attendants

FOREIGN AIRCRAFT PAKISTAN

32. **F-16**. Single engine Air Superiority Fighter both for ground attack and Air Defence. It can carry 30 mm cannon, laser guided bombs, Air to ground missile, Advanced Medium Range Air to Air missile. It is a highly agile fighter manufactured by USA.

33. **MIRAGE-V**. Single Seater Ground Attack fighter capable of carrying cannon and wide variety of air to ground and air to air missiles on seven external stations. It is manufactured by Dasault Aviation France

34. **C - 130 HERCULES**. Heavy duty transport aircraft manufactured by USA. It can carry upto 92 troops or cargo 45000 lbs

35. **SIKORSKY S – 61 (SEA-KING**). Medium Range Lift Helicopter. can accommodate 26 troops. It can also carry 840 lbs of weapons. Used in anti-submarine role, this helicopter is manufactured by USA.

SUMMARY

36. The individual has to learn to recognize aircraft. In this lesson we have learnt about how to recognize the various fighter aircrafts of IAF. Many factors are involved in making an identification of an aircraft and the distance at which it can be positively identified. Some of these are size, viewing angel, visibility, aircraft finish, visual characteristics, colour and external markings. India has a vast inventory of Aircraft. Cadets should be able to recognize and identify the various Fighter/Transport aircraft and Helicopters.

CHAPTER IV : LATEST TRENDS & ACQUISTIONS

INTRODUCTION

1. Use of science and technology in every field always improves the work efficiency, reduces the work load and increases the production rate. Lot of technological improvements have taken place in the field of aviation also. Since the mid-1960s, computer technology has been continuously developed to the point at which aircraft and engine designs are fully automated. Here is the list of modern inventions or equipment that have revolutionised the field of aviation. Autopilot, Fly by Wire, UAV, Glass cockpit Technology etc. are the gifts of modern technology.

AUTOPILOT

2. In the early days of aviation, aircraft required continuous attention of a pilot in order to fly safely. As aircraft range increased allowing flight of many hours, the constant attention led to serious fatigue. An autopilot is designed to perform some of the tasks of the pilot. A single-axis autopilot controls an aircraft in the roll axis only. A two axis autopilot controls an aircraft in the pitch and roll axis. A three axis autopilots controls aircraft in all three axis. Modern autopilots use computer software to control the aircraft. The software reads the aircraft's current position, and then controls a Flight Control System to guide the aircraft.

FLY BY WIRE

3. Fly-by-wire (FBW) is a system that replaces the conventional manual flight controls of an aircraft with an electronic interface. The movements of flight controls are converted to electronic signals transmitted through wires (hence the fly-by-wire term), and flight control computers determine how to move the actuators at each control surface to provide the ordered response. The fly-by-wire system also allows automatic signals sent by the aircraft's computers to perform functions without the pilot's input and

automatically help stabilize the aircraft

FURTHER DEVELOPMENT

Fly-by-Optics

4. Fly-by-optics is sometimes used instead of fly-by-wire because it can transfer data at higher speeds. The cables are just changed from electrical to fiber cables.

UAV

5. The UAV is an acronym for Unmanned Aerial Vehicle, which is an aircraft with no pilot on board. UAVs can be remote controlled aircraft (e.g. flown by a pilot at a ground control station) or can fly autonomously based on pre- programmed flight plans. UAVs are currently used for a number of missions, including reconnaissance and attack roles. They are predominantly deployed for military applications, but also used in a small but growing number of civil applications, such as firefighting and nonmilitary security work, such as surveillance of pipelines. UAVs are often preferred for missions that are too 'dull, dirty, or dangerous' for manned aircraft.

TYPES

6. **Target and Decoy.** Provides ground and aerial target to simulate an enemy aircraft.

7. **Reconnaissance**. Providing battlefield intelligence.

8. **Combat.** Providing attack capability for high-risk missions.

9. **Endurance**. Because UAVs are not burdened with the physiological limitations of human pilots, they can be designed for maximized on-station times. The maximum flight duration of unmanned, aerial vehicles varies widely. Internal-combustion-engine aircraft endurance depends strongly on the percentage of fuel burned as a fraction of total weight and so is largely independent of aircraft size.

GLASS COCKPIT

10. Before 1970's aircraft were not sufficiently demanding to require advance equipment like electronics flight displays. Also computer technology was not at a level where sufficient light and powerful circuit were available. The increasing complexity of transport aircraft, the advent of digital systems and growing air traffic congestion around airports began to change that.

11. The average transport aircraft in the mid-1970 had more than one hundred cockpit instrument and controls and the growing number of cockpit elements were competing for Cockpit space and pilot attention. As a result NASA conducted research on displays that could process the raw aircraft system and flight data into an integrated, easily understood picture of the flight situation, finally culminating in a full glass cockpit system.

12. A glass cockpit is an aircraft cockpit that features electronics instrument displays rather than mechanical gauge. A glass cockpit uses displays driven by flight management system that can be adjusted to displays flight information as needed. This simplifies aircraft operation and navigation and allows pilot to focus only on the most pertinent information.

ACQUISITIONS

Rafale

13. Extremely powerful, superbly agile this is a 5th generation combat aircraft from Dassault Aviation, France. Thanks to its versatility, its adaptability and its ability to meet all air mission requirements, the Rafale is the "poster child" transformational fighter which provides a way forward to air forces confronted to the requirement of doing "more with less" in an ever changing strategic environment. Rafale encompasses largest and most modern range of sensors and multiplies their efficiency with technological breakthrough. It will prove to be a game changer for Indian Air Force in the years to come. It fully complies with the requirement to carry widest range of roles with the smallest number of aircraft.

Chinook

14. Indian Air Force formally inducted 4 US made Chinook Heavy Lift Helicopters at Chandigarh. Chinook is tandem rotor Heavy Lift Helicopter serving 19 countries. Chinook is expected to greatly enhance India's capabilities across a range of Military Missions. Our country faces a multitude of security challenges and we require vertical airlift capabilities for a very diversified terrain. This aircraft was procured with India specific enhancements to increase their flexibility. This is an all-weather aircraft with state of the art NVG to permit operations in all conditions. This aircraft will redefine helilift in wide variety of terrain of India. It is a battle proven machine which has flown mission in war zones from Vietnam to Afghanistan & Iraq. Chinook is highly manoeuverable and especially suited for narrow valleys.

S-400

15. India and Russia signed an inter-governmental agreement for purchase of Russian made S-400 Triumf advanced Air Defence System. India is only the second country after China to receive these state of the art AD system. S-400 is capable of engaging standoff jammer Aircraft, Ballistic & Cruise missiles in a dense electronic warfare environment. It has an extremely accurate target acquisition and engagement radar system integrated to command force. It has operational range of 400 km and an altitude of upto 185 km. This system is claimed by Russia to be a full proof Air Defence system and is highly respected by NATO.

SUMMARY

16. Auto Pilot, Fly by wire, Glass Cockpit and UAVs are the few modern equipment we discussed here that overcome the stress level of pilot to a certain extent and increase the efficiency of man and machines up to the next level.

17. **Rafale**. Extremely powerful, superbly agile this is a Vth generation combat aircraft from Dassault Aviation, France.

18. **Chinook**. A tandem rotor Heavy Lift Helicopters serving 19 countries, Chinook is expected to greatly enhance India's capabilities across a range of Military Missions.

19. **S-400**. India and Russia signed an inter-governmental agreement for purchase of Russian made S-400 Triumf advanced Air Defence System. It has an extremely accurate target acquisition and engagement radar system integrated to command force. It has operational range of 400 kms and an altitude of upto 185 kms.

CHAPTER I : AIR CAMPAIGNS

INDO PAK WAR- 1971

1. India's commitment to peace has always been total and irrevocable. This does not, however, mean submission before force or violence. Gandhi ji always made the subtle but significant distinction between nonviolence and cowardice. Hence, when the Pakistan Air Force launched operations against us on the evening of 3rdDecember, we were left with no option but to give a fitting reply. This is what precisely our defence forces did. In the process the enemy's war machinery was given crippling blows.

2. What is more, our armed forces in conjunction with the Mukti Bahini ended the dark night of oppression and brutality in East Bengal and ushered in the new state of Bangladesh. All this was achieved in a remarkably short period of fourteen days. In fact the unconditional surrender by the enemy's one lakh armed forces is unprecedented.

Aggression by Pakistan

3. Darkness had just fallen on the evening of 3rd December 1971 when air raid alert was sounded at 6 PM in most of the cities in India. With the sounding of siren all lights went off. Everyone including the President, the Cabinet Ministers, the Members of Parliament, the newsmen were taken unaware. Soon people realised the seriousness of the situation. The cities were plunged into darkness. The AIR then revealed the unfortunate incident of unprovoked aggression by Pakistan.

4. The Pakistani Air Force and ground troops following the Israeli type pre-emptive strike had launched a massive attack on the Western front stretching from Jammu & Kashmir to Rajasthan. Pakistani Radio went on the air alleging an Indian attack, when the Pakistani planes were bombing our air fields in sneak raids. Pakistan's friend, philosopher and guide Peking's New China News Agency also broadcasted similar allegations. In addition to air raids by the Pakistani Air Force the ground forces also launched a massive attack on our border posts.

AGGRESSION ANTICIPATED

5. Though the aggression by Pakistan was sudden the Indian Govt and IAF had anticipated it. All the aircraft had been dispersed and pre-emptive strike by Pakistan resulted in damage to some of the airfields. Air Defence Guns and Knats went blazing and ensured 03 of Pakistanis Sabre jets were shot down. Throughout the conflict, in which Indian strategy was to maintain basically defensive postures on the western and northern fronts whilst placing emphasis on a lightning campaign in the east. In the West the IAF's primary tasks were disruption of enemy communications, the destruction of fuel and ammunition reserves, and the prevention of any ground force concentrations so that no major offensive could be mounted against India while Indian forces were primarily engaged in the East. On the Eastern front, our forces launched a sophisticated campaign ie rapid-moving infantry and armour advancing from three directions, airborne and heliborne assaults, missile bombardments from ships and an amphibious landing. The IAF's task being primarily direct support of the ground forces. In a classic air action four Hunters operating from Jaisalmer destroyed an entire armoured regiment at Longewala, literally stopping the enemy offensive in its tracks.

6. The IAF had good reason for satisfaction with its showing during the December 1971 conflict. Although Pakistan had initiated the war with pre-emptive air strikes against major forward air bases, the IAF rapidly gained the initiative and had thereafter dominated the skies over both fronts. In aerial combat, the IAF proved its superiority in no uncertain manner. Gnats and MiG-21s, demonstrated the superiority of IAF pilots. The MiG-21 was highly effective in short range, precision attacks which was amply demonstrated while carrying out attacks against key command centers in the capital Dacca itself.

7. It was in the Western theatre that the MiG-21 was employed in its primary task, that of air defence, escort and interception. Deployed at all the major air bases, the MiG-21FLs mounted hundreds of combat air patrol sorties over Vital Points (VP) and Vital Areas (VA), flew escort missions for bombers and were continuously scrambled to intercept hostile intruders. The MiG-21 finally met its original adversary, the F-104 Starfighter, in air combat during this conflict and in all four recorded cases of classic dog fights, the MiG-21s outclassed and out fought the F- 104s. The December 1971 war also meant the gaining of India's highest award for gallantry to the IAF. Flying Officer Nirmal Jit Singh Sekhon, flying Gnat with No 18 Squadron from Srinagar, was posthumously awarded the Param Vir Chakra.

OPERATION: SAFED SAGAR

8. Operation 'Safed Sagar' was the code name assigned to the Indian Air Force's strike to support the Ground troops during Operation Vijay that was aimed to flush out Regular and Irregular troops of the Pakistani Army from Indian Positions in the Kargil sector along the Line of Control. It was the first large scale use of air power in the Jammu and Kashmir region since the Indo-Pakistan War of 1971.

Ground Operations

9. Initial infiltrations were noticed in Kargil in early May, 1999. Because of the extreme winter weather in Kashmir it was common practice for the Indian and Pakistani Army to abandon forward posts and reoccupy them in the spring. That particular spring, the Pakistan Army reoccupied the forward posts before the scheduled time not only theirs but also the posts which belonged to India, in a bid to capture Kashmir.

10. By the second week of May, an ambush on an Indian army patrol in the Batalik sector led to the exposure of the infiltration. Initially with little knowledge of the nature or extent of the encroachment, the Indian troops in the area initially claimed that they would evict them within a few days. However, soon reports of infiltration elsewhere along the LoC made it clear that the entire plan of attack was on a much bigger scale. India responded with Operation Vijay, a mobilization of 200,000 Indian troops. However, because of the nature of the terrain, division and corps level operations could not be mounted; the scale of most fighting was at the regimental or battalion level. In effect, two divisions of the Indian Army numbering 20,000, along with several thousand from the Paramilitary forces of India and the Air force were deployed in the conflict zone. While artillery attacks softened targets in certain areas, more remote ones needed the help of the Air force.

Air Operations

11. The Indian Air Force (IAF) was first approached to provide air support on 11 May. On 21 May a Canberra on a reconnaissance mission was hit by ground fire. The flight returned to base on one engine. On 25 May, the Cabinet Committee on Security authorized the IAF to mount attacks on the infiltrators without crossing the LoC On 26 May, the go-ahead was given and the IAF started its strike role tasks. Flying from the Indian airfields of Srinagar, Avantipur and Adampur, ground attack aircraft MiG-21s, MiG-23s, MiG-27s, Jaguars and the Mirage 2000 struck insurgent positions.

12. The first strikes were launched on the 26 May, when the Indian Air Force struck infiltrator positions with fighter aircraft and helicopter gunships. The initial strikes saw MiG-27s carrying out offensive sorties, with MiG-21s and (later) MiG-29s providing fighter cover. Mi-17 gunships were also deployed in the Tololing sector.

13. However, on 27 May, the first fatalities were suffered when a MiG-21 and a MiG-27 jets were shot down over Batalik Sector by Pakistan Army. The following day, a Mi-17 was lost- with the loss of all four of the crew, when it was hit by three Stinger missiles while on an offensive sortie. These losses forced the Indian Air Force to reassess its strategy. The helicopters were immediately withdrawn from offensive roles as a measure against the man-portable missiles in possession of the infiltrators.

14. On 30 May, the Indian Air Force called into operation the Mirage 2000 which was deemed the best aircraft capable of optimum performance under the conditions of high altitude in the zone of conflict. Armed with Laser Guided Bombs (LGB) the Mirages repeatedly struck enemy positions, destroying Logistics and resupply capability of the infiltrators. The LGBs ensured accuracy and extensive damage to the deeply entrenched enemy position. The aircraft employed steep dive attacks ensuring safety.

15. The choppers used were Mi-8 and the Mi-17. The transport planes were Avro, An-32 and IL-76. According to IAF the "air strikes against the Pakistani infiltrators, supply camps and other targets yielded rich dividends. By July all the remaining intruders had withdrawn and the operation was declared a success by the IAF in having achieved its primary objectives. In the context of the war and in light of the poor information available on the infiltrations, the Indian Air Force was able to coordinate well with the Army and

provide air support to the recapture of most the posts before Pakistan decided to withdraw its remaining troops.

SUMMARY

16. Indo-Pak war 1971 commenced on 03 Dec 1971. It was for a short span of fourteen days. IAF gained complete air superiority. Gnats and MIG-21s flown by the best professionals totally outclassed the adversary.

17. 'Operation Safed Sagar' was the code name assigned to IAFs strike in support of army during 'Operation Vijay', Kargil. On 25 May 1999, CCS authorized the IAF to mount attacks on infiltrators without crossing LoC. Air operations started on 26 May. MIG-21s, MIG-23s, MIG-27s, Jaguars and Mirage -2000 repeatedly struck insurgent positions using bombs and LGBs.

CHAPTER II: MOTIVATIONAL MOVIES

1. Motivational Movies are a great source of inspiration and motivations for the young minds of NCC Cadets who would then endeavor join the great Indian Air Force. A number of movies are pertaining to own ops of 1965 War, 1971 War and the Kargil Operation. These can also include the airshows which are conducted every year at Banglore and Hindon.

2. Some movies pertaining to Air ops of World War II and the Gulf War (operation Desert Storm) could also be extremely interesting and number of good lessons can be learnt from these.

3. Besides the curriculum of Institutional Syllabus, some motivational movies should also be screened during the conduct of ATC / CATCs.

CHAPTER I: PRINCIPLE OF FLIGHT

Elementary Mechanics

"When once you have tested flight, you will forever walk the earth with your eyes turned skyward, for there you have been, and there you will always long to return." – 'Leonardo da Vinci'

1. It is essential to have a basic knowledge of elementary mechanics to understand the various Principles of Flight, because both the aircraft and the atmosphere in which it flies are matter subjected to the laws of mechanics. Terms like Mass, Density, Motion, Speed, Velocity, Acceleration, Newton's First Law of Motion, Momentum, Force, Pressure, Newton's Third Law of Motion, Weight, Work, Power, Energy, Law of Conversation of Energy, Moment of a Force, Couple, and Equilibrium are to be studied.

2. **Mass**. Unit - Kilogram (kg) - 'The quantity of matter in a body.' The mass of a body is a measure of how difficult it is to start or stop, ("a body", in this context, means a substance. Any substance a gas, a liquid or a solid).

3. **Density**. It is the mass per unit volume.

4. **Motion**. Motion is said to be there when a body changes its position in relation to its surroundings.

5. **Speed**. Speed is the rate of change of position.

6. **Velocity**. Velocity is speed in particular direction. Velocity is a vector quantity having both magnitude and direction.

7. **Acceleration**. Acceleration is the rate of change of velocity. The change may be in magnitude or direction or in both. Thus a body moving along a circular path at constant speed has acceleration.

8. **Newton's First Law of Motion.** A body will continue to be in state of rest or of uniform motion in a straight line unless acted upon by an external force. This property of all bodies is called inertia and a body in such a state is said to be in Equilibrium.

9. **Momentum**. Unit – Mass x Velocity (kg-m/s) – The quantity of motion possessed by a body. The tendency of a body to continue in motion after being placed in motion.

10. **Force.** Unit - Newton (N) -'A push or a pull', which causes or tends to cause a change in motion of a body.

11. **Pressure.** Pressure is force per unit area.

12. **Newton's Second Law of Motion.** The rate of change of momentum of a body is directly proportional to the applied force and takes place in the direction of the application force.

13. **Newton's Third Law of Motion.** To every action, there is an equal and opposite reaction.

14. **Weight.** The earth exerts a certain force towards its centre on all objects on its surface. This force is called Weight of the body and is equal to the mass of the body multiplied by the acceleration due to gravity 'g'.Unit - Newton (N) - 'The force due to gravity'. (F = m x g).

15. **Work.** Unit - Joule (J) - A force is said to do work on a body when it moves the body in the direction in which the force is acting. The amount of work done on a body is the product of the force applied & distance moved by the body in the direction of the force. If a force is exerted and no movement takes place, no work has been done.

"Work = Force x Distance (through which the force is applied)"

16. **Power.** Unit - Watt (W) - Power is simply the rate of doing work, (the time taken to do work)

$$\text{Power (W)} = \frac{\text{Force (N) x Distance (m)}}{\text{Time (s)}}$$

17. **Energy**. Unit - Joule (J) - Mass has energy if it has the ability to do work. The amount of energy a body possesses is measured by the amount of work it can do. The unit of energy will therefore be the same as work, joules.

18. **Law of Conversation of Energy**. The sum total of all energy in the universe remains constant.

19. **Equilibrium**. A body is said to be in equilibrium when:-
(a) Algebraic sum of all the forces acting on the body is zero.
(b) Clockwise moment is equal to the anti-clock wise moment about any point.

20. **Centre of Gravity (CG)**. The point through which the weight of an aircraft acts.
(a) An aircraft in flight is said to rotate around its CG.
(b) The CG of an aircraft must remain within certain forward and aft limits, for reasons of both stability and control

21. **Kinetic Energy**. Unit - Joule (J) - 'The energy possessed by mass because of its motion'. 'A mass that is moving can do work in coming to rest'.

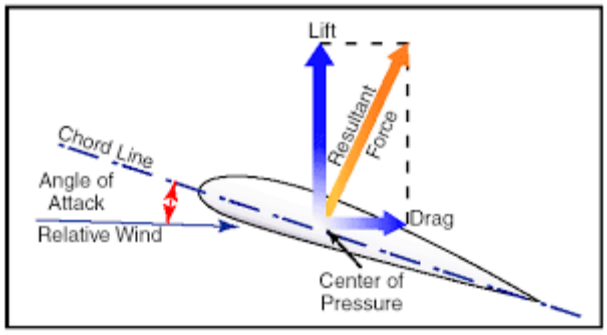
$$KE = {}^{1}/_{2}\, m\, V^{2} \text{ joules}$$

PRINCIPLES OF FLIGHT: GLOSSARY OF TERMS

"Do not let yourself be forced into doing anything before you are ready" *Wilbur Wright*.

22. The following are the main Glossary of Terms which are required for understanding, Principle of Flight.

23. **Aerofoil**. A body designed to produce more lift than drag. A typical aerofoil section is cambered on top surface and is more or less straight at bottom.



24. **Chord Line.** It is line joining the centers of curvature of leading and trailing edges of an aerofoil.

25. **Chord Length**. It is the length of chord line intercepted between the leading and trailing edges.

26. **Angle of Attack**. It is the angle between the chord line and the relative air flow undisturbed by the presence of aerofoil.

27. **Angle of Incidence.** The angle between the chord line and the longitudinal axis of the aircraft.

28. **Total Reaction**. It is one single force representing all the pressures (force per unit area) over the surface of the aerofoil. It acts through the center of pressure which is situated on the chord line.

29. **Lift.** The vertical component of Total Reaction, resolved at right angles to the relative airflow.

30. **Drag**. The horizontal component of the Total Reaction acting along and in the same direction as the relative airflow.

AEROFOIL

31. Aerofoil is the shape of a wing or blade (of a propeller, rotor or turbine) as seen in cross-section. An airfoil-shaped body moved through a fluid produces an aerodynamic force. The component of this force perpendicular to the direction of motion is called lift. The component parallel to the direction of motion is called drag.

32. Fixed-wing aircraft's wings, horizontal, and vertical stabilizers are built with aerofoil shaped cross sections, as are helicopter rotor blades, propellers, fans, compressors and turbines.

33. Any object with an angle of attack in a moving fluid, such as a flat plate will generate an aerodynamic force (called lift) perpendicular to the flow. Aerofoils are more efficient lifting shapes, able to generate more lift with less drag. It is the basic structure of ac which supports ac in air. Aerofoil design is a major facet of Aerodynamics. Movable high-lift devices, flaps and sometimes slats, are fitted to aerofoils on almost every aircraft.

SUMMARY

34. A flying object is a mechanical body in a three dimensional space. The knowledge of above definition is necessary for effective understanding of Principle of Flight.

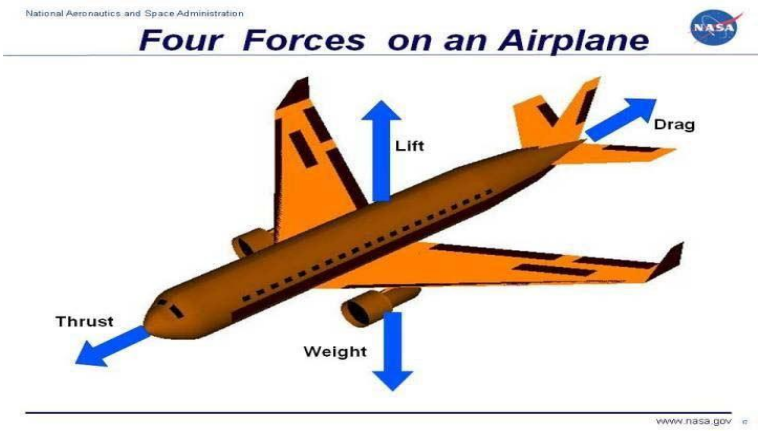
CHAPTER II : FORCES ACTING ON AIRCRAFT

"It is possible to fly without motors, but not without knowledge and skill". Wilbur Wright.

(This chapter is to be explained on the micro-light for better understanding of this complex topic)

1. An Aircraft is considered to be in straight and level flight when it is flying at a constant altitude and speed, maintaining lateral level and direction. Force acting on aircraft at any given moment are Lift, Drag, Thrust and Weight.

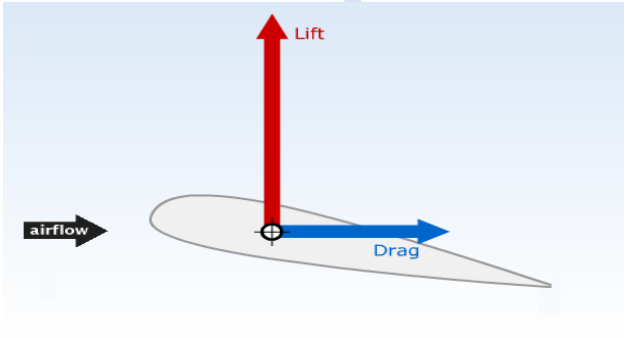
2. **Lift** is a positive force caused by the difference in air pressure under and above a wing. The higher air pressure beneath a wing creates lift, and is affected by the shape of the wing. Changing a wing's angle of attack affects the speed of the air flowing over the wing and the amount of lift that the wing creates.

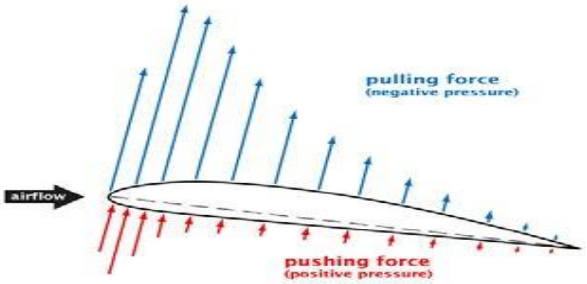


3. **Weight** is the force that causes objects to fall downwards. In flight, the force of weight is countered by the forces of lift and thrust.

4. **Thrust** is the force that propels an object forward. An engine spinning a propeller or a jet engine expelling hot air out the tailpipe are examples of thrust.

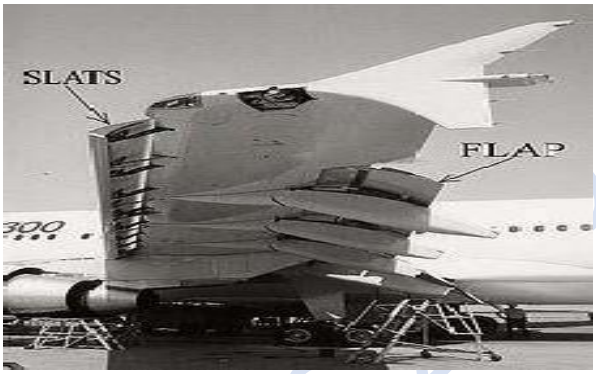
5. **Drag** is the resistance of the air to anything moving through it. Different wing shapes greatly affect drag. Air divides smoothly around a wing's rounded leading edge, and flows neatly off its tapered trailing edge. This is called streamlining.





6. Lift and Drag are the most important components of aircraft in level flight. They act in 90^0 to each other. The Lift component of aircraft supports the aircraft in air whereas the drag resist the aircrafts movement through the air.

FORCES ACTING ON AIRCRAFT: FLAP & SLATS



1. Flaps are hinged surfaces mounted on the trailing edges of the wings of a fixed- wing aircraft to reduce the speed at which an aircraft can be safely flown and to increase the angle of descent for landing. They shorten takeoff and landing distances. Flaps do this by lowering the stall speed and increasing the drag. Flaps increase the camber and also the surface area of the wing thereby increasing lift.

2. Slats are aerodynamic surfaces on the leading edge of the wings of fixed-wing aircraft which, when deployed, allow the wing to operate at a higher angle of attack. A higher coefficient of lift is produced as a result of high angle of attack. So by deploying slats an aircraft can fly at slower speeds, or take off and land in shorter distances. They are used while landing or performing manoeuvers which take the aircraft close to the stall, but are usually retracted in normal flight to minimize drag. Types of slats:-

(a) **Automatic.** The Slat lies flush with the wing leading edge until reduced aerodynamic forces allow it to extend by way of aerodynamics when needed.

(b) **Fixed**. The Slat is permanently extended. This is sometimes used on low-speed aircraft (these are referred to as slots) or when simplicity takes precedence over speed.

(c) **Powered.** The Slat extension can be controlled by the pilot. This is commonly used on airliners.

3. Flaps are aerodynamic surface mounted on the trailing edge of the wing. They increase lift, drag and lower the approach speed of the aircraft. Slats are similar to flaps but mounted on the leading edge of the wings.

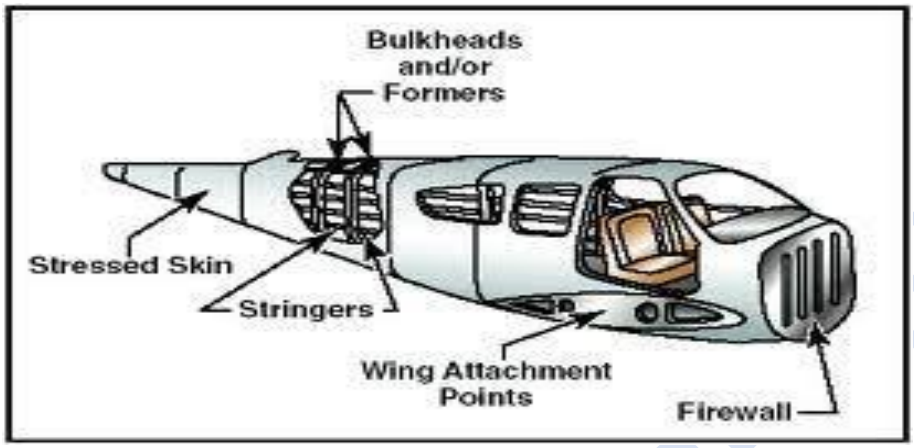
PARTS OF AIRCRAFT

4. **FUSELAGE**. Fuselage is the main body of the aircraft to which all the other components are attached it also contains the cockpit from where the pilot controls the aero-plane. It provides the space for the freight and passengers.

BASIC DESIGN

5. The basic design of fuselage should satisfy the following:-
   (a) Smooth skin of the required aerodynamic form.
   (b) Sufficient strength to withstand aerodynamic loads, landing loads and handling loads.
   (c) Sufficient stiffness to retain its correct shape under all loads.
   (d) Mounting points for engine, armament, fuel tanks and equipment.
   (e) Protection of aircrew and passengers from ambient conditions.
   (f) Sufficient break down points for easy dismantling for transportation and port- holes accessible for inspection and servicing.
   (g) Design itself should be economical and easy for production and repairs.

6. A basic fuselage layout is shown below for easy understanding. As can be seen, it comprises fire wall, wing attachment points, landing gear attachment points, stringers, bulk head/formers and stressed skin.

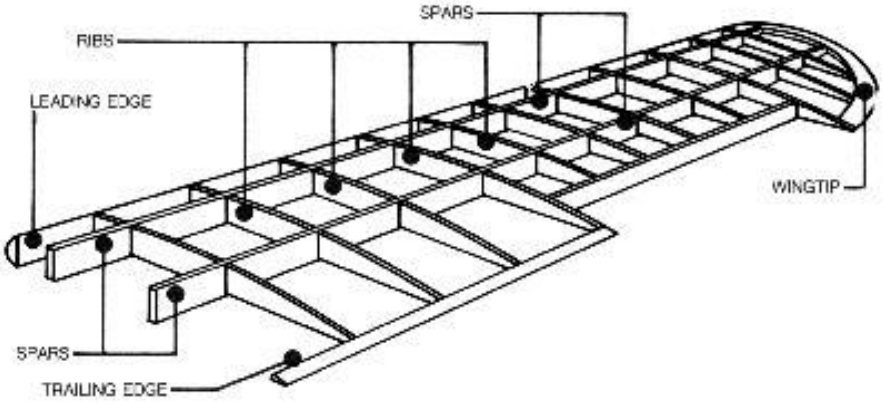


MATERIALS USED

7. Early aircraft were constructed of wood frames covered in fabric. As monoplanes became popular, metal frames improved the strength, which eventually led to all-metal aircraft with metal covering all surfaces. Some modern aircraft are constructed with composite materials for major control surfaces, wings, or the entire fuselage such as the Boeing 787. Hence the various types of materials can be classified as follows:-

(a) Wood
(b) Metals.
(c) Composites

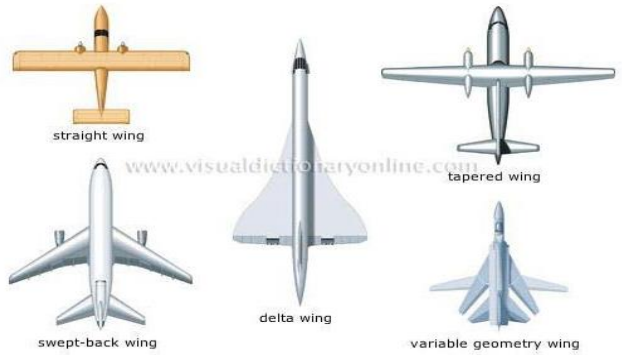
MAIN PLANE



8. As shown in figure above, a wing is a type of fin with a surface that produces lift for flight or propulsion through the atmosphere. As such, wings have an airfoil shape, a streamlined cross-sectional shape producing a useful lift to drag ratio.

9. There are various types of wings as shown in figure below. They are as follows:-

(a) Straight wing.
(b) Swept back wing.
(c) Delta wing.
(d) Tapered wing.
(e) Variable geometry wing.

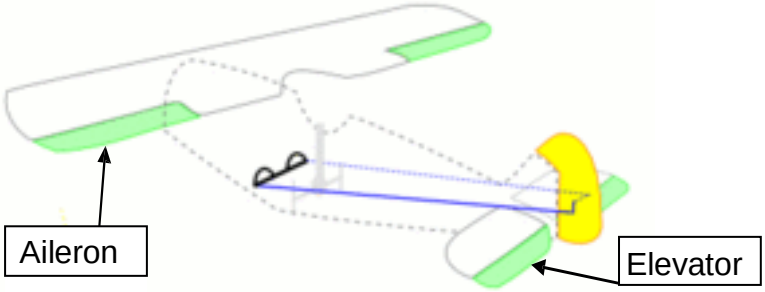


AILERONS, ELEVATORS AND RUDDERS

10. The main control surfaces such as Aileron and Elevators of a fixed-wing aircraft are attached to the airframe on hinges or tracks so that they may move and thereby deflect the air stream passing over them. This redirection of the air stream generates an unbalanced force to rotate the plane about the associated axis. The rudder is a fundamental control surface in order to provide means of controlling yaw of an airplane about its vertical axis.

AILERONS

11. The figure shows the position of Aileron and Elevator on an aircraft.



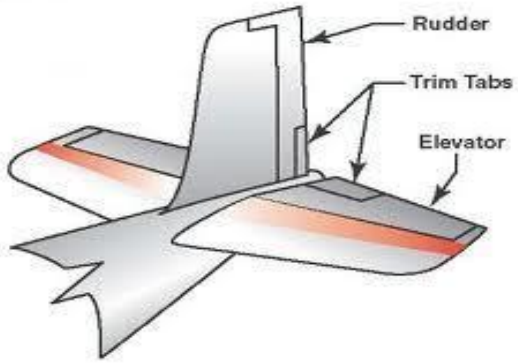
12. Ailerons are mounted on the trailing edge of each wing near the wing tips and move in opposite directions. When the pilot moves the stick left, the left aileron goes up and the right aileron goes down. A raised aileron reduces lift on that wing and a lowered one increases lift, so moving the stick left causes the left wing to drop and the right wing to rise. This causes the aircraft to roll to the left similar effect occurs when the stick is moved right.

ELEVATORS

13. An elevator is mounted on the trailing edge of the horizontal stabilizer on each side of the fin in the tail, as shown in the figure above. They move up and down together. When the pilot pulls the stick backward, the elevators go up. Pushing the stick forward causes the elevators to go down. Raised elevators push down on the tail and cause the nose to pitch up ie.the aircraft commences a climb.

RUDDER

14. A typical view of Rudder is shown below.



15. The rudder is a fundamental control surface, typically controlled by pedals It is the primary means of controlling yaw ie the rotation of an airplane about its vertical axis. On an aircraft, the rudder is a directional control surface. The rudder is usually attached to the fin (or vertical stabilizer) which allows the pilot to control yaw about the vertical axis, i.e. change the horizontal direction in which the nose is pointing.

SUMMARY

16. Chapter is to be covered as a practical class on the micro-light for better assimilation. Primary controls and secondary controls are the most essential control systems for all types of aircraft. Several technology research and development efforts exist to integrate the functions of flight control systems such as ailerons, elevators, and flaps into wings to perform the aerodynamic purpose with the advantages of less mass, lower cost, reduced drag and inertia (for faster, stronger control response). Few important definitions are given below:-

(a) **Lift**. A positive force caused by difference of air pressure over and below the wing.

(b) **Weight**. Force that causes objects to fall downwards.

(c) **Thrust**. Force that propels an object forward.

(d) **Drag**. Resistance to the air to anything moving through it.

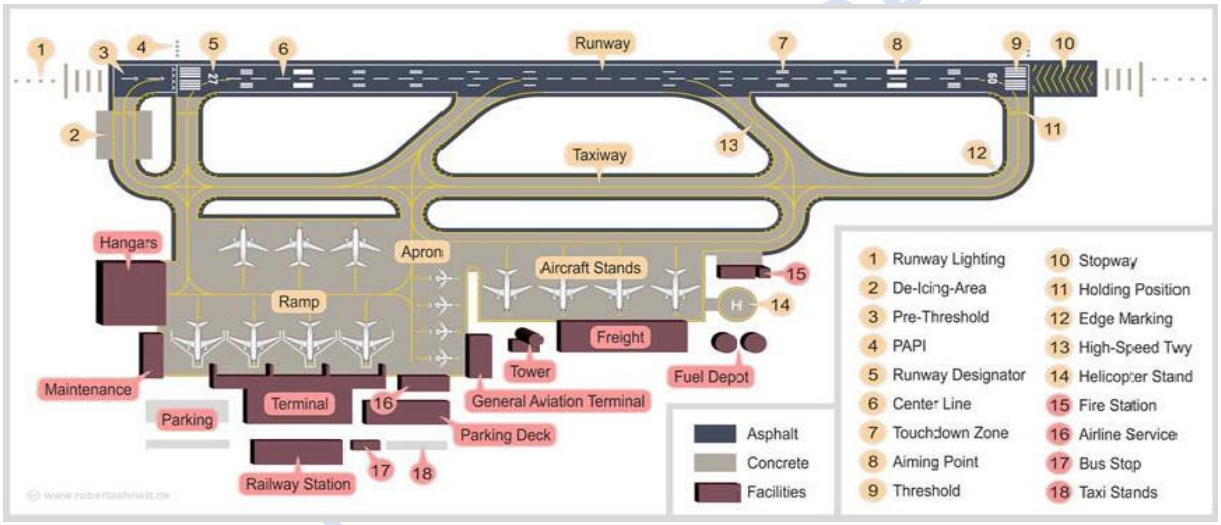
AIRMANSHIP

CHAPTER I: VISIT TO AIRFIELD (ATC AND MET)

1. **Visit to Airfield**. For better understanding of the Airfield layout the cadets should be taken to the ATC and practically shown the Airfield layout and working of ATC, including R/T procedures. The sitting, layout and physical characteristics of an airfield should facilitate safe, orderly and expeditious flow of air traffic. The basic areas associated with physical characteristics have been standardized for all airfields / aerodromes with subsequent amendments from time to time. The standardized physical characteristics have been worked out considering most of the aircraft available today and standardized by DGCA conforming to international rules and regulations.

AIRFIELD LAYOUT

2. Following are the areas laid down at the airfields to facilitate safe and expeditious conduct of aircraft operations:-



3. **Movement Areas**. Movement areas are that part of an airfield intended for the surface movement of the aircraft. These are paved areas and include runways, taxiways, dispersal areas, aprons etc.

4. **Flight Strip.** It is the rectangular portion of an airfield containing the runway and paved over-runs along with the shoulders and cleared zones.

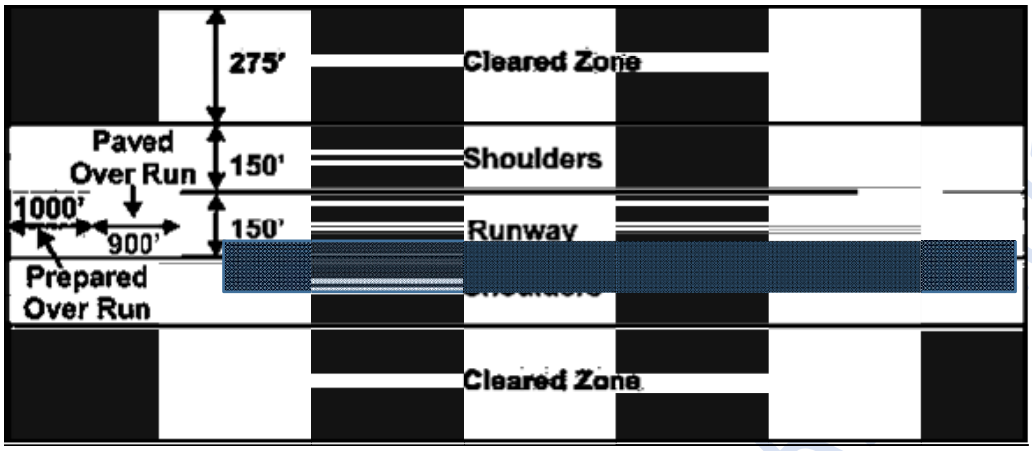
5. **Runways.** Runways are paved surfaces intended for take-off and landing of ac. The number and orientation of runways at an airfield will depend upon the volume of traffic, runway occupancy time and climatological data on surface winds.

6. **Taxiways.** These are paved surfaces provided for the taxing of aircraft and intended to provide a link between one part of the aerodrome and another.

7. **Shoulders.** These are areas immediately adjacent to the edges of the runway, taxiways, over-runs and SGAs prepared for accidental or emergency use in the event of an aircraft running off the paved surface.

8. **Cleared Zones**. These are those areas of the flight strip adjacent to the shoulders which for safety of aircraft operations, should be levelled as far as possible.and free of.obstructions.

9. **Over-Run Areas**. A defined rectangular area on ground at the end of runway in the direction of take-off prepared as a suitable area in which an aircraft can be stopped in case of abandoned take off, or during a landing emergency.

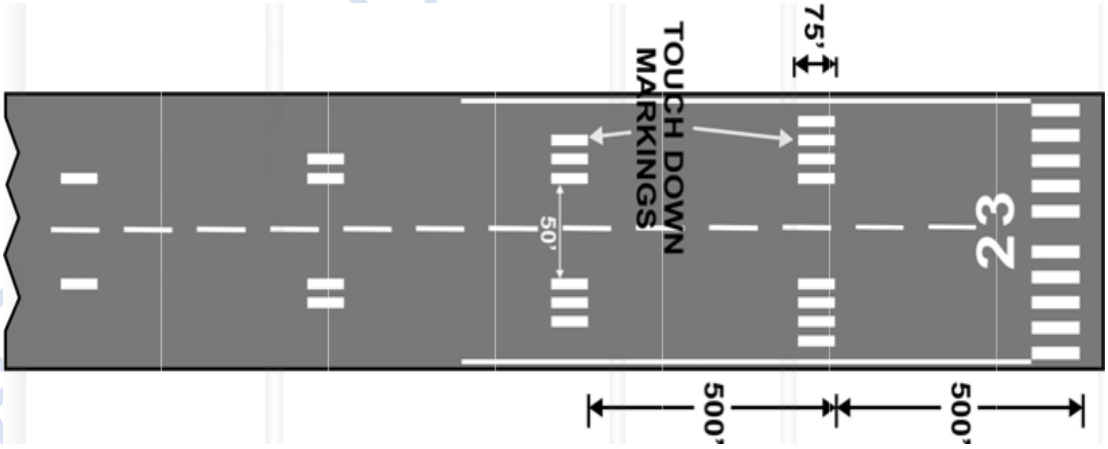


AERODROME MARKINGS

10. Aerodrome markings consist of signs on surface of movement areas to convey aeronautical information.

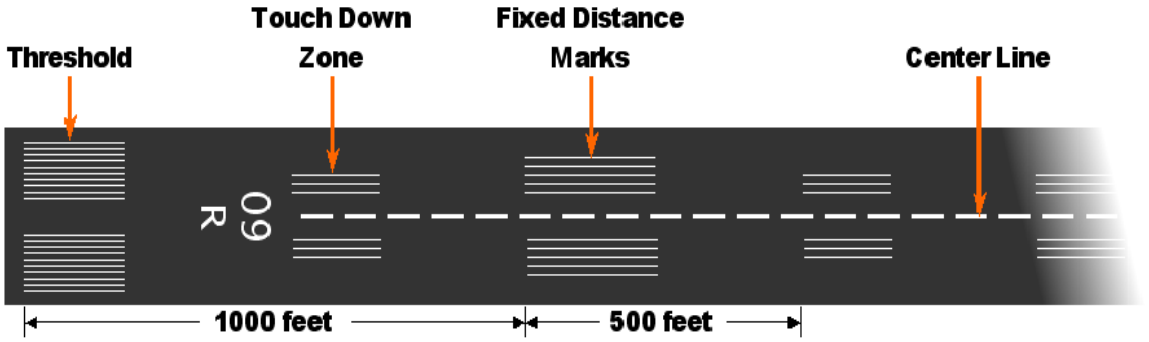
11. Aerodrome ground markings shall consist of the following:

(a) Runway markings.
(b) Taxiway markings.
(c) Unserviceability markings.



12. **Runway Markings**. Runway markings shall consist of:-

(a) **Runway Designation Markings**. Runway designation markings shall consist of a two-digit number and on parallel runways shall be supplemented by a letter. The two digit number designates the magnetic heading of the runway.



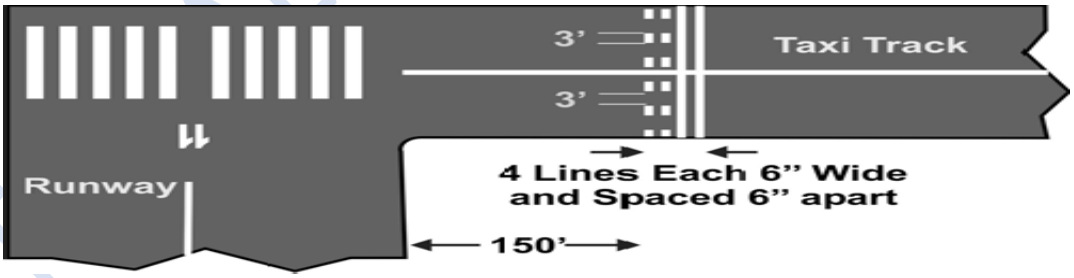
(b) **Runway Centre Line Markings**. Runway center line markings shall consist of a series of broken longitudinal lines along the runway center line and extending along the whole length of the runway.

(c) **Runway Touch Down Zone Markings**. Touch down zone markings shall be located over the first 600 m (2000 ft) of instrument runways at longitudinal spacing of 150 m (500 ft). These markings shall be provided with distance coding.

(d) **Runway Side Strip Markings**. Side strip markings shall be provided on all paved runways. These markings shall consist of two lines extending the whole length of the runway parallel to and equidistant from runway center line.

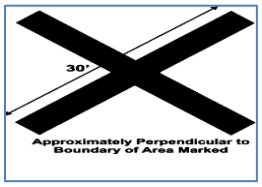
13. **Taxiway Markings.** These markings shall consist of:-

(a) **Taxiway Centre Line Markings** These markings shall be single unbroken line 0.15 m (6") wide along the center line of taxiway.



(b) **Runway Holding Position Markings**. These markings shall consist of four lines of 0.15 m (6") width each with spacing of 0.15 m (6").

(c) Unserviceability Markings Unserviceability markings shall be displayed on those parts of movement area, which are unfit for landing, take-off or surface movement of aircraft. Unserviceability markings shall be in the form of a cross as given.



14. **Aerodrome Lighting**. There are several types of approach and airfield lighting in use in the service. All permanent installations are normally on the mains electricity supply but also have some alternative arrangements for use in the event of power failure. Aerodrome lighting is considered under two headings.

(a) **Approach Lighting**. This is to assist the pilots to make an approach for landing in poor visibility or at night.

(b) **Airfield Lightings**. Modern installation consist of raised high intensity white lights along each side of the runway, beamed towards the landing aircraft. At the beginning of runway, called the thresh hold, is a bar of green lights going across the full width of the runway.

SUMMARY

15. The concept of airfields has changed considerably since the early days of flying. The earlier aircraft needed comparatively small, level grass areas. However, as the aircraft became faster, their landing and take-off runs became longer and the airfields had to be enlarged to meet their ends. The modern tendency, therefore, is for operations to be confined to one or at the most two runways on each airfield. The longest of these runways is usually designed for instrument landings in bad weather and it is known as instrument runway having full, lighting, radio, radar and instrument landing facilities. Today the runways are even more than 6000 yds long and 200 ft wide and constructed of concrete surface with asphalt to give a clean and smooth finish.

CHAPTER II : VISIT TO MET SECTION AND ATMOSPHERE

1. The cadets are to be taken to Met Section during the visit to Airfield for practical demonstration of Met Section working. Meteorology is the study of the atmosphere and the weather processes that occur in it. Since an aircraft is flown through a medium of the atmosphere, an aviator must have adequate knowledge of meteorology and an appreciation of the effect of weather on all aspects of flying.

IMPORTANCE OF MET IN AVIATION

2. Since meteorology is the science dealing with the study of atmosphere and an aircraft is designed to fly through this medium, various weather processes and changes that occur in the atmosphere has great significance for aviators.

3. Meteorological briefing is undertaken to explain to the aircrew the prevailing met conditions and expected conditions (forecast) over the required areas of operation. The met officer gives the following information:-

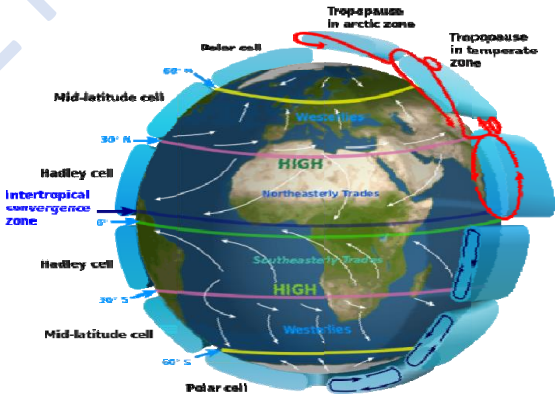
(a) Salient features observed on latest weather charts.

(b) Present state of weather at base and diversionary air fields with emphasis on the aspects that are adverse for flying.

(c) Forecast for base and diversionary airfields for the next 6-12 hours with specific mention of weather warnings that may be in force and the likelihood of its extension.

ATMOSPHERE

4. The invisible and odorless gas which we breathe, which sustains life and produces an infinite variety of phenomena is what we call air. The envelope of air surrounding the earth and extending to great heights is the atmosphere where physical processes occur, giving rise to the ever changing weather phenomena.



COMPOSITION OF AIR

5. Air is a mechanical mixture of a variety of gases. The main constituents of this mixture are nitrogen and oxygen, accounting for almost 99% of the whole, with roughly three parts of nitrogen to one part of oxygen. There are small amounts or traces of other gases. This composition is more or less the same up to about 60 kilometers.

6. The composition of dry air by volume is as:-

(a)	Nitrogen	78.09 %.
(b)	Oxygen	20.95 %.
(c)	Argon	0.93 %.
(d)	Carbon dioxide	0.03 %.

7. The atmosphere is never completely dry. Water vapour is always present in varying amounts. Water vapour also behaves as a gas. It is the change in the amount and state of the water vapour

(solid, liquid, gas) which is important in the physics of the weather processes in the atmosphere .Apart from water vapour suspended particles like dust, smoke causes reduction in visibility. In the higher layers there is a concentration of Ozone between 30 and 50 km.

LAYERS OF ATMOSPHERE

8. While the pressure and density decrease as the height increases, the variation of temperature is different. Due to this there is a tendency for the atmosphere to be divided into several spheres as mentioned below:-

(a) Troposphere- Up to about 11-16 km

(b) Stratosphere- Up to about 50 km above troposphere.

(c) Mesosphere 50 to 85 km.

(d) Thermosphere above 85 km.

Troposphere

9. The troposphere is the region nearest to the earth and is generally the region of weather. It has a more or less uniform decrease of temperature with height. The lapse rate is roughly 6.5°c /km (1.98°c /1000feet). The upper boundary of the troposphere is called the tropopause whose height varies from equator to the poles, being highest at the equator (16-18 km) and lowest over poles (8-10 km).

Stratosphere

10. The stratosphere is the layer extending from the tropopause to about 50 km. The temperature in this region is steady or increases with height.In the higher stratosphere the temperature is of the order of 0°c. The upper boundary of the stratosphere is the stratopause.

Mesosphere

11. The layer above the stratosphere is the mesosphere, where the temperature again decreases with height. The boundary of the mesosphere is the mesopause, about 85 km high, where the lowest temperature in the atmosphere is found (about - 90°c).

Thermosphere

12. Above the mesosphere is the thermosphere. Its upper limit is undefined. However at about 700 km, the gravitational pull of the earth is practically absent and the particles can escape from the atmosphere into space. This region is often referred to as exosphere.

Ionosphere

13. The lower thermosphere is in a highly ionized state and is hence called ionosphere. This layer causes reflection of radio waves communication possible and makes long wave radio possible.

International Standard Atmosphere

14. A standard average atmosphere has to be specified for various purposes like the design and testing of aircraft, evaluation of aircraft performance, calibration of pressure altimeter etc. For this purpose a standard atmosphere is defined and used as a basis of references. The most widely used atmosphere for reference purposes is the one defined by ICAO, known as International Standard Atmosphere (ISA) whose specifications are:-

(a)	Mean Sea level temperature	-	15°c.
(b)	Mean Sea level pressure	-	1013.25 mb.
(c)	Surface density	-	1225 g/m3.
(d)	Acceleration due to gravity	-	980.665 cm / sec2.
(e)	Rate of fall of temp with height up to 11 km		6.5°c /km (1.98°c / 1000 ft.

ATMOSPHERIC PRESSURE

15. Pressure is due to weight of the air above sea level. Atmospheric pressure at any level in the atmosphere refers to the weight of the column of air of unit cross section vertically above the point of observation. In other words air has weight and therefore exerts a pressure which is equivalent to a column of air extending vertically till the total height of atmosphere. This pressure is expressed in various units like millibars, hectapascal etc. When an aircraft climbs away from the earth surface the height of the column of air above it decreases and therefore the weight and pressure exerted by that column decreases (Atmospheric pressure decreases with height). This rate of decrease of atmospheric pressure is found to be 1millibar for every 30 feet of height (and vice- versa).

SUMMARY

16. The atmosphere extends from the surface of earth till about 500 miles. Troposphere is the layer closest to earth surface and is most important to aviation. Weather processes occurring in troposphere affect aviation. Atmospheric pressure varies from place to place depending on temperature and cause high pressure and low pressure areas. Air moves from high pressure to low pressure area and this motion of air is called wind.

17. **Layers of Atmosphere**

(a)	Troposhere	Up to about 11-16 km.
(b)	Stratosphere	Up to about 50 km above troposphere.
(c)	Mesosphere	50 to 85 km.
(d)	Thermosphere	Above 85 km.

CHAPTER.I: AEROMODELLING CAPSULE

History of Aeromodelling

"When once you have tasted flight, you will forever walk the earth with your eyes turned skyward, for there you have been, and there you will always long to return." Leonardo da Vinci.

1. Aero-modelling is one of the finest & costly hobbies, which is very popular worldwide among people of all ages and professions. It has often been the starting point of many pilot/ aero-nautical careers. The aim of including aero-modelling in the NCC curriculum is to enhance the interest among NCC cadets. If taken on the right lines, it can be extremely thrilling for all, as by constructing the models by one's own hands, will make understanding of various principles of flight easy, apart from providing great personal satisfaction to the aero- modeler.

2. The history of aero-modelling goes back much further than the history of real aircraft. The successful experiments, however, started in the nineteenth century. Dr. Thomas Young was the first person to discover the 'lifting' property of a cambered surface in comparison to the flat surface. Sir George Caley built a helicopter model, based on a design of Leonardo-da-vinci, in 1796. Another great name amongst the pioneers of aero-modelling is of Alphones Penand, who invented models fitted with tail surfaces and wings with dihedral angles. This gave substantial stability of flight to aero models, which till this time had lasted for very short duration. After this, came the era of miniature petrol-driven engines. Later, these gave way to more powerful engines, which are in use even today.

MATERIALS USED IN AEROMODELLING

3. Aero-modelling requires a variety of materials. Selection of correct material and proper use of the same is important factor of Aero-modelling. The following are the main substances from which the Aero-models can be made:-

(a) (d)	Balsa Wood Ply wood.	(b) (e)	Spruce Cement.	(c) (f)	Japanica Wood Fast Setting Epoxy.
(g)	Cyanoacrylate Glue (Cyano).			(h)	Putty.
(j)	Metal paste.	(k)	Dope.	(l)	Paint.
(m)	Sand paper.	(n)	Fiber glass.	(o)	Carbon Fiber.
(p)	Silver Foil.	(q)	Monokote		

4. **Basic tools**.

(a) Screw driver.
(b) Hand drill.
(c) Sand paper and pins.
(d) Pliers.
(e) Knives with different blades.
(f) Different kind of saw.
(g) Files Soldering irons.
(h) RC set (Transmitter, Receiver, Servos).

5. After selection of good materials and required tools one has to handle these tools carefully. Mishandling of tools may cause serious injuries to the Aeromodellers / builders.

TYPES OF AEROMODELS

6. The following are the different type of Aero models:-

(a) **Static Models**. These are the miniature replicas of original aircrafts. The following aircrafts can be prepared as static models.

(i) Fighter aircraft models.
(ii) Transport aircraft models.
(iii) Helicopter models.

(b) **Gliders**. These are the different types of gliders:-

(i) Chuck Glider.
(ii) Catapult Glider.
(iii) Towline Glider.
(iv) Free flight Glider.

(c) **Control Line Models**. The following are the different types of Control Line model**:-**

(i) Control Line Aerobatic Model.
(ii) Control Line Speed Model.

(d) **Radio control Models**.The following are the different types of Control Line model**:-**

(i) Radio Control Power.
(ii) Radio Control Glider.
(iii) Radio control Helicopter.
(iv) Jet Powered Model.

7. The ‘aero-modelling provides an earnest approach to the understanding of an otherwise highly technical subject, i.e ‘aerodynamics. This ‘air-minded’ aero-modeller of today is the potential aircraft designer of tomorrow. Although, aero-modelling is a technical hobby and is usually cluttered up with complicated calculations and formulae, it need not necessarily discourage the beginners and the non-technical persons, as they can still derive immense pleasure and satisfaction from this hobby. Aero-modelling is becoming increasingly popular all over the country especially amongst the NCC Cadets

CHAPTER II : BUILDING AND FLYING OF AEROMODELS

Construction of Static Models

1. These are the miniature replicas of original aircrafts, full sized aircraft types and requires the best skill of the model maker. The scope of this particular type is boundless and depends upon the ideas of the individual concerned. It requires only an elementary knowledge of carpentry and involves fitting together of various parts as well as finishing and painting of the models.

2. Construction plans are provided normally with all model kits. These should be studied thoroughly. Then follow the shaping of various parts using sandpaper and sand blocks as shown in the blue print. After which the whole plan is fixed on the drawing board. Then the individual parts are placed on the blue print and it is to be ensured, it is proper as per the blue print. Parts are then assembled together as per the dimensions provided in the blue print. Dope is applied with brush but only in thin coats two to three times. Sand the excess dope using a fine emery paper.

3. **Painting.** Apply a coat of surfacer using a brush or spray gun and make sure it has covered all the wooden area. After the surfacer is dried up check for dents and apply putty or metal paste to cover the dents. After it dries up using a wet emery paper, sand the model to get a clean surface till it is suitable for painting. 'Etch rivet marking' as shown in the blue print. Spray a thin layer of base coat and paint the model as per the required colour scheme. Add details, undercarriage, wheels, drop tanks etc. & apply lacquer or polish if required.

CONSTRUCTIONS OF CONTROL LINE MODELS

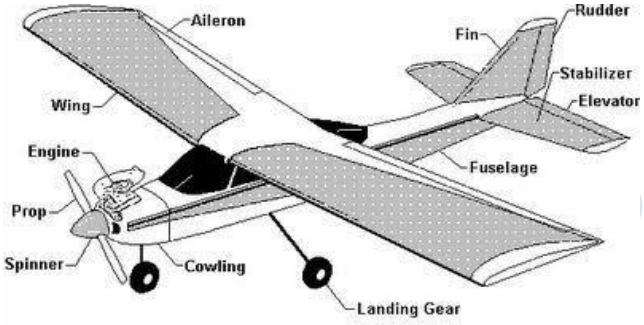
4. Each and every part of a model aero plane is important as it would not function in the absence of even one component. Construction plans are provided normally with all model kits. These should be studied thoroughly. Then follows the actual construction of various parts. The power units are, also available in readymade forms, and are required to be installed as they are as per the power / weight combination prescribed by the manufactures

5. First, the whole plan is fixed on to the drawing board. Then the individual parts are fixed on it with the help of pins parts are then glued together with cement. After drying, the various components are assembled together with correct alignment. Sand papers of various grades are used for smoothening out of edges and curves. Patience and meticulous operation is needed at this point. Assemble the bell crank assembly with the lead outs carefully. Model is then covered with sliver foil, monokote or tissue paper. Dope may be applied with brush, in thin coats two to three times.

6. Before engine installation, ensure that the engine compartment is properly treated with paint work. While installing the engine, extreme care is needed to be taken to ensure that the thrust line of the propeller is in line with the fuselage. Out of line thrust will result in the model going hay wire and crashing. Engines are mounted either by projection made of hard wood beams or on screws against the plywood.

CONSTRUCTIONS OF REMOTE CONTROL MODELS

7. Each and every part of a model aero plane is important as it would not function in the absence of even one component.



Basic Trainer

8. Construction plans are provided normally with all model kits. These should be studied thoroughly. Then follows the actual construction of various parts. The power units are, also available in readymade forms, and are required to be installed as they are, as per the power/weight combination prescribed by the manufactures.

8. First, the whole plan is fixed on to the drawing board. Then the individual parts are fixed on it with the help of pins parts are then glued together with cement. After drying, the various components are assembled together with correct alignment. Sand papers of various grades are used for smoothening out of edges and curves. Patience and meticulous operation is needed at this point. Model is then covered with sliver foil, monokote or tissue paper. Dope may be applied with brush, in thin coats two to three times.

9. Before engine installation, ensure that the engine compartment is properly treated with paint work. While installing the engine, extreme care is needed to be taken to ensure that the thrust line of the propeller is in line with the fuselage. Out of line thrust will result in the model going hay wire and crashing. Engines are mounted either by projection made of hard wood beams or on screws against the plywood.

10. Install the Radio-control servos as per the requirement to make sure the control rods should move freely without causing any disturbance to the other control rods. Wrap the receiver and the battery pack in foam and place it in the model in such a way that the CG of the model is correct as per the marking shown in the plan by the manufacturer of the kit. Then assemble the wing using a pairs of rubber bands or nylon screws.

FLYING THE MODELS

11. The necessity of choosing a large field for flying the aero models is obvious. However, trees and wooded areas are the greatest hazards for the aeromodeller. Trees cause air pockets and down-draughts and often 'suck' the model into their branches.

12. First check the model for correction of alignment. The wing and tail must be checked from the front and rear for setting and must not be warped or out of plane. Testing is carried out during mid-day when there is little or no wind. The model is held on the point of balance i.e. approximately 1/3rd back from leading edge of the wing, and is gently launched into wind slightly nose down attitude. If the model is set properly and trimmed correctly, it will glide forward gracefully and will land on wheels. Use plasticine or lead weight at the nose and tail for balance as required.

13. Power flight is not advisable till the gliding test is carried out successfully. For trial flight, a small amount of fuel is put into the fuel tank and the engine started by rotating the propeller. The model is to be launched gently. A nicely balanced model would fly a short distance and land perfectly.

GENERAL SAFETY CODE

14. The following is the general safety code:-

(a) I will not fly my model aircraft in competition or in the presence of spectators until it has been proven to be airworthy by having been previously successfully flight tested.

(b) I will not fly my model higher than approximately 400 feet within 3 miles of an airport without notifying the airport operator. I will give right of way to, and avoid flying in the proximity of full scale aircraft. Where necessary an observer shall be utilized to supervise flying to avoid having models fly in the proximity of full scale aircraft.

(c) Where established, I will abide by the safety rules for the flying site I use, and I will not willfully and deliberately fly my models in a careless, reckless, and/or dangerous manner.

RADIO CONTROL SAFETY CODE

15. The following is the radio control safety code:-

(a) I will have completed a successful radio equipment ground range check before the first flight of a new or repaired model.

(b) I will not fly my model aircraft in the presence of spectators until I become a qualified flyer, unless assisted by an experienced helper.

(c) I will perform my initial turn after takeoff away from the pit, spectator, and parking areas, and I will not thereafter perform manoeuvers, flights of any sort, or landing approaches over a pit, spectator, or parking area.

SUMMARY

16. The construction/building of static models is one of the main event in all India level competitions like AIVSC and RDC. In AIVSC, the given static model has to be built in stipulated time and for RDC competition, three different static models have to be built that is fighter, transport and helicopter. The construction of control line model is slightly advanced as compared to tow line glider and free flight models. In this model, there is only one control surface for most control line aircraft; the up and down movement of the elevator on the stabilizer. The rudder is set so the aircraft will always pull away from the flier (to help keep the control line taut). Remote control model is fitted with radio receiver sets of actuators which operate the control surfaces of the model. The radio receiver receives signal from the control box which is operated by the “pilot”. The control box is nothing, but a transmitter, with various channels for operating the respective controls including throttle. This way, the model can be operated without physical contact.

CHAPTER I: MAPS

1. This chapter is combined with flying. Topographical map is one in which a good pictorial representation of a country is portrayed and is provided mainly to be used for map reading. Actual map used in Flying should be used to explain this chapter.

2. The four basic elements required in a map are:

(a) Areas will be shown correctly.
(b) Bearing measurement anywhere on the reduced earth will be identical to the measurement on the earth.
(c) Shapes will be correct.
(d) Distances will be measured accurately by use of a graduated scale which is provided at the bottom of each map. The distances are given in
(i) Kilometers
(ii) Nautical miles.
(iii) Statute miles.

3. In aviation both maps and charts are used for Navigation. When a projection has a graticule of latitudes, longitudes and an abundance of ground features it is called a map. A chart has a projection on which it contains a graticule of latitude and longitude with very few geographical features.

4. **Relief**. Mountains, hills, coast lines and other natural features are of considerable interest to a pilot as they are valuable landmarks for navigation purpose or are, sometimes pose dangerous barriers for flight. Relief is indicated on maps and charts in one or more of five different ways:-

(a) Spot heights or depths.
(b) Contours and form lines.
(c) Layer tints.
(d) Hachures.
(e) Hill shading.

SYMBOLS USED IN MAPS

5. The details on topographical maps are shown by symbols, some of which are pictorial in nature, while others are given by a symbol which is accepted internationally. These symbols are used to denote the details of a map and these are called as conventional signs.

6. The beginner is sometimes confused by the amount of detail confronting his untrained eye. He must learn to distinguish the more significant features and to remain undistracted by irrelevant back ground. The following may help to indicate the important features which is of value.

(a) Coast line.
(b) Water Features.
(c) Mountains and hills.
(d) Towns and Villages.
(e) Railways.
(f) Roads.

SCALES OF MAPS

7. The scale is the ratio of a distance measured on the map to the corresponding distance on the earth surface. Scale on a map is represented commonly by:-

(a) Representative fraction.

(b) Graduated scale line.

(c) Statement in words.

8. Most common maps used in aviation are ¼ million maps, ½ million maps and 1 million maps. ¼ million maps have larger scale than ½ million and ½ million have scale larger than 1 million. A larger scale map represents comparatively lesser ground distance and consequently more ground details can be inserted.

9. Air Navigation is an important aspect of aviation and learning the skills involved in good navigation techniques is an important aspect of flight training. Once these techniques are learned on ground, they must be put to practice to gain experience in pilot navigation technique as sorties from day to day will differ depending on conditions, situations and environment.

ATC RT PROCEDURE

10. As an Air Wing NCC cadet it is must to know about ATC &RT procedure prior to start flying. Timely information of weather, wind speed, position are the essential parameters for flying. To access all the timely required information for a safe operation we must know the ATC & RT procedure.

DEFINITIONS

11. **Air Traffic Services**. Services provided for the safe and efficient conduct of flight are termed as air traffic services.

12. **Objectives of Air Traffic Services.**

(a) To prevent collision between aircraft.
(b) To prevent collision between aircraft on the maneuvering area and obstructions on that area.
(c) To expedite and maintain an orderly flow of traffic.
(d) To provide advice and information useful for the safe and efficient conduct of flights.
(e) To notify appropriate organisations regarding aircraft in need of search and rescue aid and assist such organisation as required.

13. The ATS include the following:-

(a) Air Traffic Control Services:
  (i) Area Control Service.
  (ii) Approach Control Service.
  (iii) Aerodrome Control Service.
(b) Flight Information Service.
(c) Air Traffic Advisory Service.
(d) Alerting Service.

14. **Approach Control Service.** ATC service for arriving or departing controlled flights.

15. **Aerodrome Control Service.** ATC service for aerodrome traffic.

16. **Air Traffic Service Units**.

(a) **Approach Control Office.** A unit established to provide air traffic control service to controlled flights arriving at or departing from, one or more aerodromes.

(b) **Aerodrome Control Tower.** A unit established to provide air traffic control service to aerodrome traffic.

RT PROCEDURES AND PHRASEOLOGY

Letter to be Identified	Identifying Word	Representation of Pronunciation in English
A	Alfa	Alphah
B	Bravo	BrahVoh
C	Charlie	Charlee (or Shar Lee)
D	Delta	Dell Tah
E	Echo	Eck Oh
F	Foxtrot	Foks Trot
G	Golf	Golf
H	Hotel	Hoh tell
I	India	In Dee Ah
J	Juliet	Jew Lee Et
K	Kilo	Key Loh
L	Lima	Lee Mah
M	Mike	Mike
N	November	No Vem Bar
O	Oscar	Oss Car
P	Papa	PahPah
Q	Quebec	Qeh Beck
R	Romeo	Row Me Oh
S	Sierra	See Airrah
T	Tango	Tang Go
U	Uniform	You Nee Form
V	Victor	VikTah
W	Whiskey	Wiss Key
X	X-Ray	Ecks Ray
Y	Yankee	Yan Key
Z	Zulu	Zoo Loo

Pronunciation of Numbers

1	One	Wun
2	Two	Too
3	Three	Tree
4	Four	Fower
5	Five	Fife
6	Six	Six
7	Seven	Saveen
8	Eight	Ait
9	Nine	Niner
0	Zero	Zee Row
.	Decimal	Day - See - Mal
1000	Thousand	Tou - sond

All numbers except whole thousand will be transmitted by pronouncing each number separately. Whole thousands shall be transmitted by pronouncing each digit in the number of thousand followed by the word thousand. Some of the examples are:

Number	
10	One Zero
75	Seven Five
100	One Zero Zero
583	Five Eight Three
5000	Five Thousand
25000	Two Five Thousand

MICROLIGHT FLYING

17. It is recommended that minimum of 10% of meritorious JD/JW Cadets be given one sortie of 15 minute duration. This will ensure optimum utilization of micro-light aircraft. A waiver can be given by ADG/DDG of the Dte in case of NO / Unserviceable Micro Light Aircraft or Runway under repair.

18. Also along with Flying, visit to ATC and Met Section is to be combined for better understanding of ATC procedure and working of Met Section.

19. Parts of the Aircraft and some aspects of Aerodynamics are to be explained on the micro-light itself.

SIMULATOR FLYING

20. Simulator Flying will be carried out as and when simulators are made available to the unit.