SD/SW

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

ADVISORY PANEL

- Lieutenant General Rajeev Chopra, AVSM, DG NCC
- Major General Sanjay Gupta, VSM, ADG (B) HQ DG NCC

STUDY TEAM

- Brigadier SP Sinha, Group Commander, Ghaziabad (UP)
- Colonel GS Dhillon , SM UP Dte
- Colonel Rahul Srivastava, SM TN&P Dte
- Captain (IN) RK Saini, PHHP&C Dte
- Group Captain Neeraj Amba, UP Dte
- Lieutenant Colonel Narain Dass, UP Dte
- Major R S Shekhawat, OTA, Kamptee

CONSULTATIVE SUPPORT TEAM

- Brigadier Ajay Kumar Mahajan, Brig Trg, HQ, DG NCC
- Colonel Manish Sinha, Trg Dte, HQ DG NCC
- Col Vijay Kumar Trg Dte, HQ DG NCC

SECRETARIAL SUPPORT

- Mr Jai Prakash, Senior Assistant
- Mr Manoj Bisht, Senior Assistant

SD / SW (AIR) SPECIALISED SUBJECTS

BLOCK SYLLABUS

S.No	Subject	Periods			
		First Year	Second Year	Third Year	Total Periods
1	General Service Knowledge	03	06	03	12
2	Air Campaigns	-	03	09	12
3	Principles of Flight	03	03	-	06
4	Airmanship	04	03	-	07
5	Navigation	03	03	-	06
6	Aero Engines	03	03	01	07
7	Basic Flight Instruments	03	-	-	03
8	Aero Modelling	09	06	09	24
Total		**31**	**31**	**28**	**90**

SD/SW (AIR) SPECIALISED SUBJECTS

INDEX

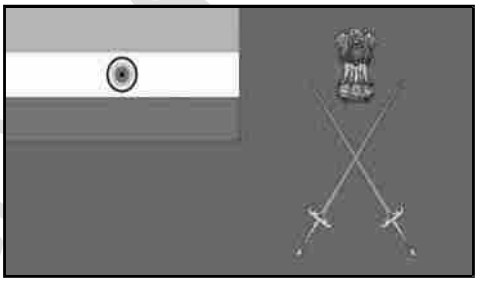
DETAILED SYLLABUS

CHAPTER-I : ARMED FORCES & IAF CAPSULE

BASIC ORGANISATION OF ARMED FORCES

1. As a Cadet of NCC, it is very important to understand the basic organisation of our Armed Forces. An overview of the command and control structure shows how finely it has been tuned to meet India's security requirements, based on the major wars that it has fought and the present day relations between India and its neighbours.

Army



2. The Indian Army is the land based branch and the largest component of the Indian Armed Forces. It is the second longest steading Army in the world. The President of India serves as the Supreme Commander of the Indian Army, and it is commanded by Chief of Army staff (COAS),who is a four star general.. The Chief of Army Staff is the head of the Indian Army and is responsible for all army activities. Officers who assist him are:-

(a) Vice Chief of Army Staff.
(b) Two 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 called Army Commander or GOC – in - C. The whole country is divided into seven theatre Commands who have subordinate formations under them. These are:-

Command Insignia	Command Name	Headquarters
	Headquarters , Indian 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

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 (Bharatiya 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, a four-star officer in the rank of Admiral, commands the navy. The Indian Navy is the fifth 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 2017, the Indian Navy has a strength of 67,109 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: -

Commands	**Headquarters**
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 is the Supreme Commander of the IAF. The Chief of Air Staff, an Air Chief Marshal, is a four-star officer and commands the Air Force.

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 Operations.
(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: -

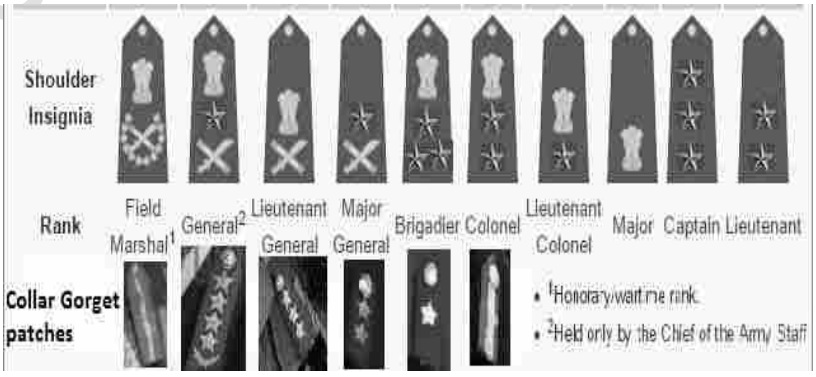
Commands	Headquarters
Operational commands	
Central Air Command (CAC)	Allahabad, Uttar Pradesh
Eastern Air Command (EAC)	Shillong, Meghalaya
Southern Air Command (SAC)	Thiruvananthapuram, Kerala
South Western Air Command (SWAC)	Gandhinagar, Gujarat
Western Air Command (WAC)	New Delhi
Functional Commands	
Training Command (TC)	Bangalore, Karnataka
Maintenance Command (MC)	Nagpur, Maharashtra

BADGES OF RANKS

10. The Indian Armed Forces consists of three professional uniformed services: the Indian Army, Indian Navy, and Indian Air Force. All the three services have distinct Badges of ranks which help in identifying soldiers and their commanders. The ranks of Badges are given as per professional competence and length of service in Armed Forces.

COMMON MILITARY RANKS		
Navy	**Army**	**Air Force**
Admiral of the Fleet	Marshal or Field Marshal	Marshal of the Air Force
Admiral	General	Air Chief Marshal
Vice Admiral	Lieutenant General	Air Marshal
Rear Admiral	Major General	Air Vice Marshal
Commodore	Brigadier	Air Commodore
Captain	Colonel	Group Captain
Commander	Lieutenant Colonel	Wing Commander
Lieutenant Commander	Major	Squadron Leader
Lieutenant	Captain	Flight Lieutenant
Sub Lieutenant	Lieutenant	Flying Officer

11. **Commissioned Officers: Army**. Commissioned Officers of Indian Army are those who command their troops from Platoon or equivalent up to Corps and higher and hold Presidents commission. Field Marshal is an honorary rank and is given to a General for his valuable services. K.M Cariappa was awarded the rank of Field Marshal in the year 1986 for his valuable services to Indian Army.S.H.F.J Manekshaw was Army Chief in 1971 war against Pakistan which liberated Bangladesh. He was awarded the Rank of Field Marshal for his exemplary leadership during the war. A Field Marshal is a Five Star Rank. The badges of rank worn by commissioned officers are as given under:-



12. **Junior Commissioned Officer (JCO) Army**. The second set of officers in the Army is Junior Commissioned Officers. The soldiers who become JCOs join the Army as sepoys and come up through the NCO ranks. The ranks of Subedar Major, Subedar and Naib Subedar are used in the Infantry and other Arms and Services. While the ranks of Risaldar Major, Risaldar and Naib Risaldar are used in the Armed Corps. The badges of rank worn

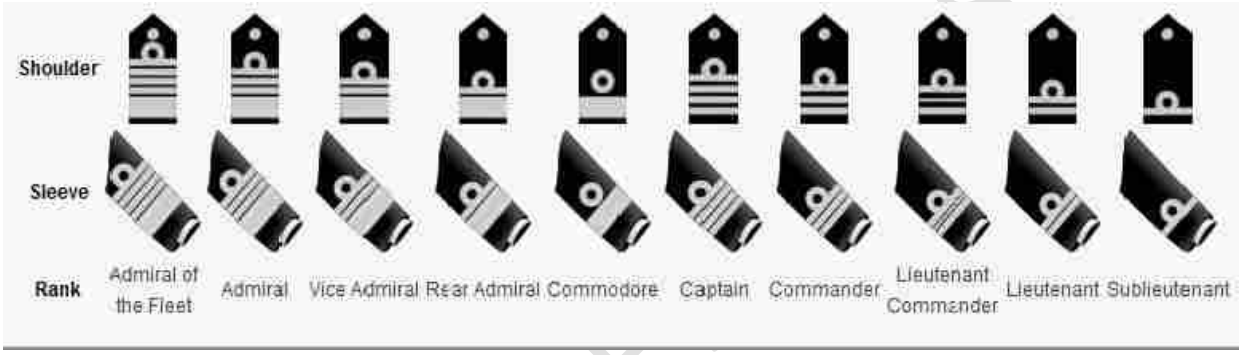
by the JCOs are :-

Non Commissioned Officer (NCO) Army

13. 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 :-

Badges of Rank- Navy

14. **Commissioned Officers : Navy.** Admiral of the Fleet is an honorary rank given to an Admiral for his invaluable service 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:-



15. **Junior Commissioned Officers (JCOs) Navy**. The badges of rank worn by these Officers are:-

Non Commissioned Officers (NCOs) Army

16. The badges of rank worn by the NCOs are:-

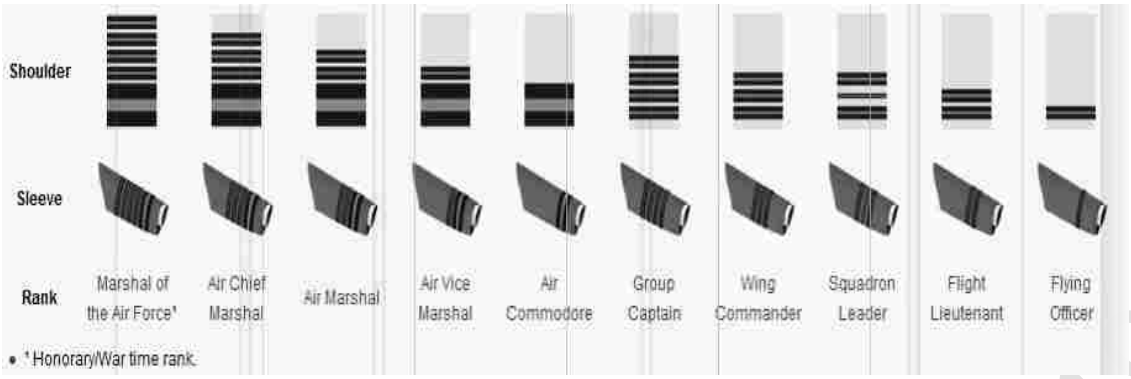
PETTY OFFICER

LEADING SEAMAN

LEADING SEAMAN-II

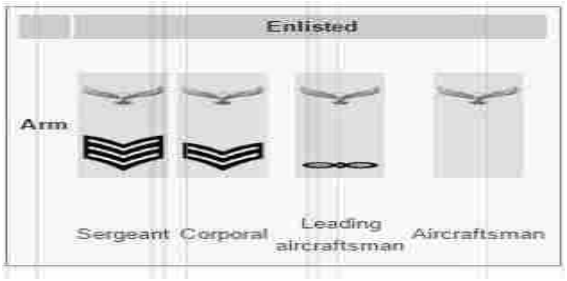
Badges of Rank- Air Force

17. **Commissioned Officers : Air Force**. Marshal of the Air Force is an honorary rank given to an Air Chief Marshal for his invaluable service. In recognition of his services the Government of India gave the rank of Marshal of the Air Force to Arjan Singh in January 2002 making him the first and the only “Five Star” rank officer in the Indian Air Force. The badges of rank worn by



18. **<u>Junior Commissioned Officers (JCOs) Air Force</u>**. The badges of rank worn by these Officers are:-

19. **<u>Non Commissioned Officers (NCOs) Air Force</u>**. The badges of rank worn by these NCOs are:-



<u>HONOURS AND AWARDS</u>

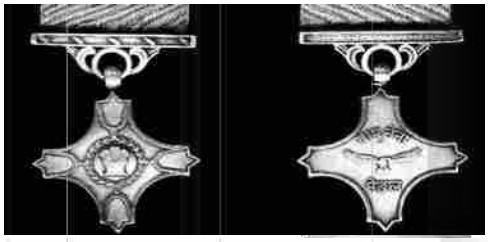
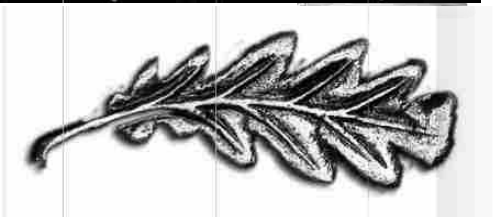
20. The Armed Forces of India are awarded many military decorations, honours and awards. The awards and honours are awarded for extraordinary bravery and courage, as well as for distinguished service during times of war and peace. For the purpose of classification, Indian Armed Forces honours and awards can be divided into two categories:

(a) Gallantry Awards
(b) Non-Gallantry wards / Distinguished Service Awards

GALLANTRY AWARDS

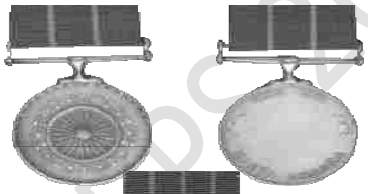
21. Gallantry awards are divided into two categories:

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

S. No	Name of the Award	Image
(i)	Param Vir Chakra	
(ii)	Maha Vir Chakra	
(iii)	Vir Chakra	
(iv)	Sena Medal	
(v)	Nao Sena Medal	

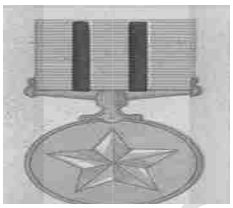
(vi)	Vayu Sena Medal	
(vii)	Mention in Despatches	
(viii)	Chiefs of Staff Commendation Card	

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

S. No	Name of the Award	Image
(i)	Ashoka Chakra	
(ii)	Kirti Chakra	
(iii)	Shaurya Chakra	

PART III –NON-GALLANTRY /DISTINGUISHED SERVICE AWARDS

S. No	Name of the Award	Image
(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	

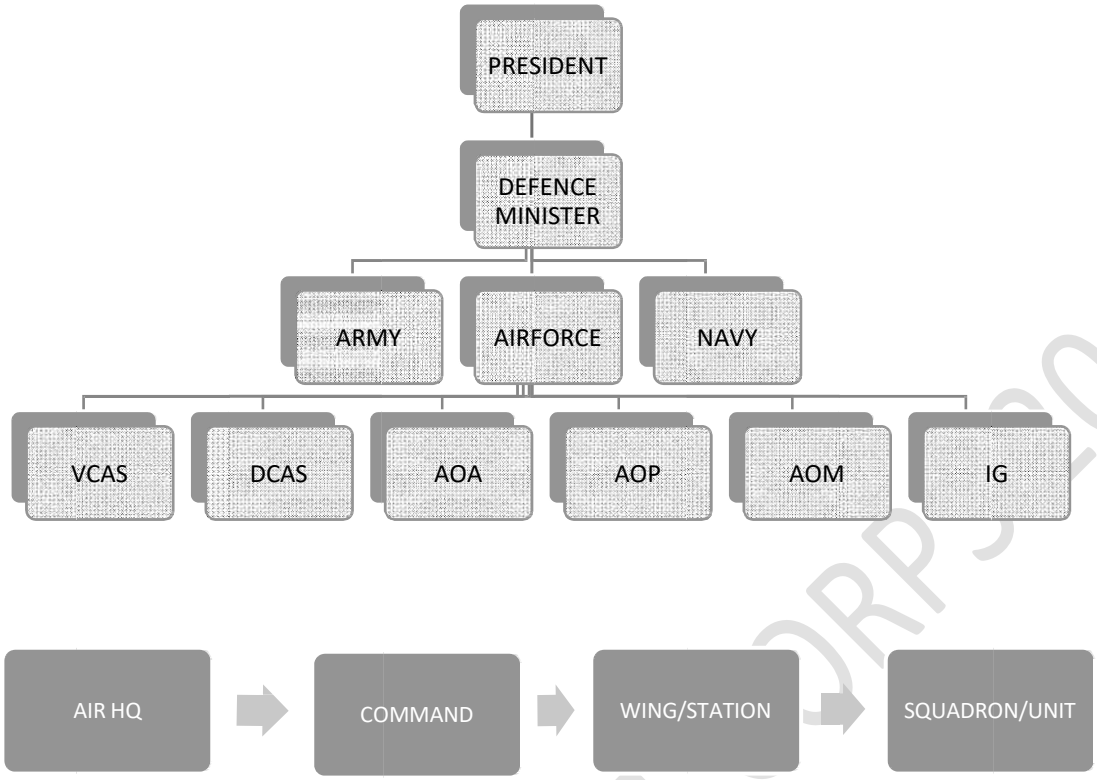
<u>NOTE</u> Award like Sena Medal is given for all three catagories i.e. during War, Peace and also as a Distinguished Award.

ORGANISATION OF IAF

22. 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.

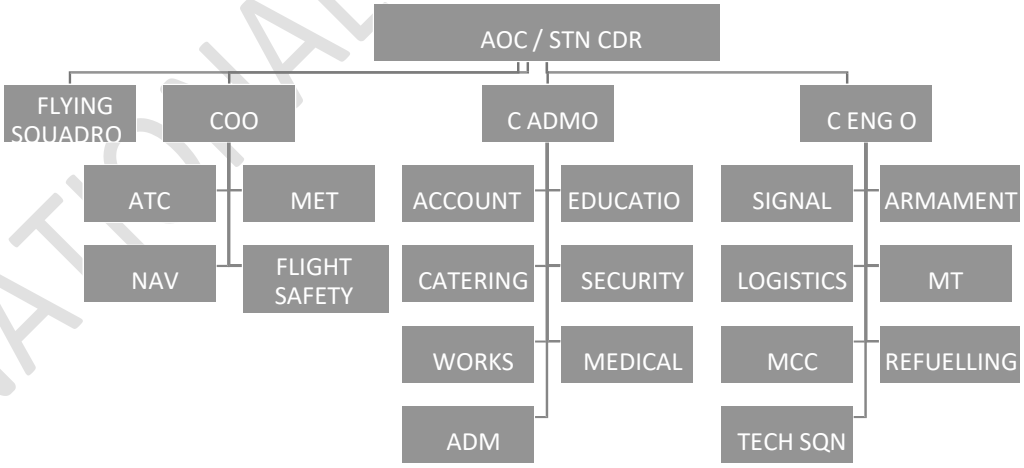
AIM

23. To teach the NCC cadets about the organization of IAF

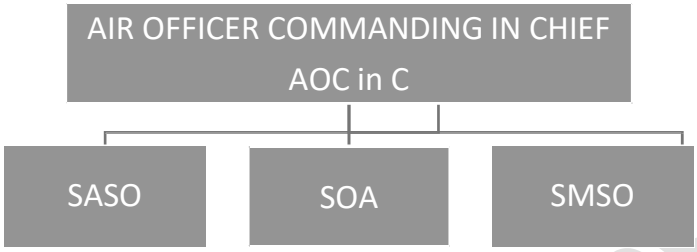


STATION/WING

24. Station/Wing is always what is called a self-accounting unit, i.e 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



COMMANDS

25. The Western, Central, Eastern, South Western, Southern Air Commands control all operational units. Operational Commands execute the operational roles of the Air Force in war. They also handle the training of paratroopers for airborne operation. Training Command is responsible for training of Officers and Airmen in all flying and ground training at various academy/training institution/colleges under it. Maintenance Command is responsible for the maintenance, repair and storage of aircraft, MT, Signal equipment, Armament, Ammunition and explosives etc, and exercise functional and administrative control over Base Repair Depot (BRDs) and Equipment Depot (EDs).

26. Following are the Air Command with their Head Quarters:-

Southern Air Command	-	Trivandrum
Training Command	-	Bangalore
Eastern Air Command	-	Shillong
Maintenance Command	-	Nagpur
Western Air Command	-	New Delhi
South West Air Command	-	Gandhi Nagar
Central Air Command	-	Allahabad

HISTORY OF IAF

27. 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.

28. 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

29. 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.

30. 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. 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.

31. 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

32. 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.

33. 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

34. 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 organization of the Air Force and having a few personnel now it 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. As an Officer in the Indian Air Force, you will inherit a glorious heritage and timeless traditions of the IAF, blended perfectly with the latest technology.

3. As an officer in the Indian Air Force you will strategise, lead and manage. Depending on your qualifications, you could join one of the various branches in the IAF. Broadly the Air Force has three branches with further sub-streams :

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

Branch/Type of Entry	Educational Qualification	Age Limit	Advertisement Schedule
(A) FLYING BRANCH			
1.National Defence Academy (NDA) For Men only	10+2 With Physics & Math	16 1/2 –19	Mar/Oct
2. Combined Defence Service (CDSE) For Men only	Any Grad. With Physics & Math at 10+2 or BE	19-23	Apr/Sep
3. NCC Special Entry	Any Grad. with Physics & Math at 10+2 or BE&NCC Air Wing Sr Div. "C' Certificate	19-23	Jun/Dec
4. Short Service Commission (For Women only)	Any Grad. With Physics Maths at10+2 or BE	19-23	Mar/Sep
(B) TECHNICAL BRANCH (PC For Men/ SCC For Women)			
1. Aeronautical Engineering (Electronics) 2. 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
(C) GROUND DUTY BRANCH (PC For Men / SCC For Women			
1. Administration	First Class Graduate or PG in	20-23	Mar/Sep

2. Logistics 3. Accounts	subjects as per advertisement	20-25	
4. Education 5. Meteorology	PG in subjects as per advertisement	20-25	Mar/Sep

5. **Airman Entry**. The initial period of engagement in the IAF is 20 years, which can be extended up to the age of 57 years. Promotion prospects up to the rank of Master Warrant Officer exist to the deserving airmen. Opportunities to become a Commissioned Officer also exist for those airmen who qualify the prescribed examination, later in their service career.

(a) **Service Entry Commission**. Airmen of the rank of Sergeant & above with 10 years of minimum service and within the age limit of 34 to 42 years get the opportunity to become a Commissioned Officer in the IAF.

(b) **Honorary Commission**. Selected MWOs/WOs are granted Honorary Commission in the last year of their service before superannuating on Republic Day and Independence Day each year. On grant of Honorary Commission, they are eligible for higher scales of pay and allowances.

Job Contents: Trade Wise

6. On the basis of the performance in the Joint Basic Phase Training (JBPT) at Basic Training Institute, Belgaum specific trades are allotted to the successful candidates. Basic combatant training is imparted to all the recruits, which includes basic discipline and manners, educational training, weapon training etc. After successful completion of basic training, you will be trained in specific trades. PT, Parade and games are integral part of the training and service life. Succeeding paragraphs give an idea of the nature of job an airman is expected to perform in different trades. However, depending on service requirement, an airman may be assigned other jobs as required by his superior authorities and exigencies of service.

7. **Group 'X' (Technical) Trades**. In this trade you are responsible for maintenance and repair of all types of light and heavy duty mechanical vehicles, cranes and loading equipment etc.

(a) Electronics Fitter
(b) Electrical Fitter
(c) Mechanical System Fitter
(d) Structures Fitter
(e) Propulsion Fitter
(f) Workshop Fitter (Smith)
(g) Workshop Fitter (Mechanical)
(h) Weapon Fitter

8. **Group 'X' (Non – Technical)Trades.**

(a) Education Instructor

9. **Group 'Y" (Non –Technical) Trades.**

(a) Adm Assistant
(b) Accts Assistant
(c) Medical Assistant
(d) Logistics Assistant
(e) Environment Support Services Assistant (ESSA)
(f) Ops Assistant

(g) Meteorological Assistant
(h) Ground Training Instructor
(j) Indian Air Force (Police)
(k) Indian Air Force (Security)
(l) Musician

10. **Group 'Y' (Technical) Trades.**

(a) Communication Technician
(b) Automobile Technician

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

GROUP	"AGE (As on date olf Enrolment	EDUCATIONAL QUALIFICATION
Group 'X' (Technical) Trades	17-22 Years	Passed Internediate / 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 , Boilogy and English with a minimum of 50% marks in aggregagte.
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 GSK-III-AIRCRAFTS TYPES CAPABILITIES & ROLE

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.

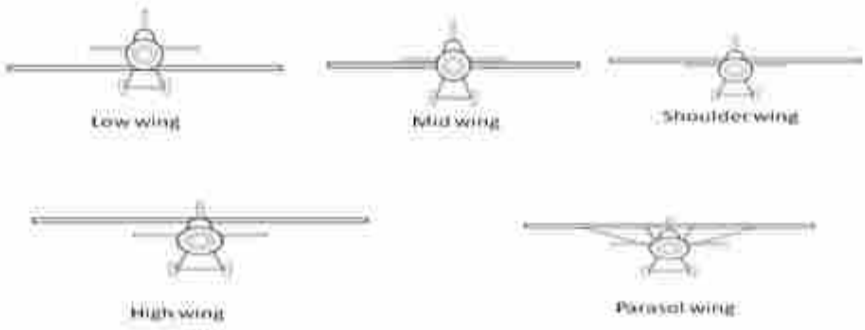
3. **During War Time**. Aircraft recognition helps the MOP (mobile observation post) to identify the Aircraft as friend or foe. It also helps to know the capability of the aircraft by identifying its type.

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

(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

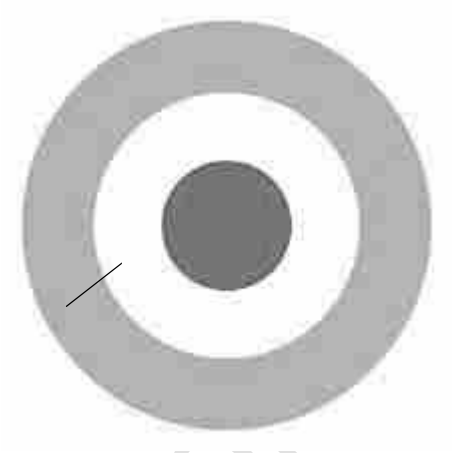
(d) Glasshouse
(e) Bubble

7. **Shape of Fin and Tail Plane.**

(a) High tail plane
(b) Low mid tail plane
(c) High mid tail plane
(d) Mid tail plane
(e) Low tail plane

8. **Markings**.

GREEN WHITE SAFFRON



FIGHTER AIRCRAFT

9. **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).

10. **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.

11. **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.

12. **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.

13. **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.

14. **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 CCMs (overwing) alongwith 4750 kg of external stores (bombs/fuel).

TRANSPORT AIRCRAFT

C-130J : The aircraft is capable of performing paradrop, 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.

15. **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

16. **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 tonnes freight, wheeled or tracked armoured vehicles.

17. **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 tonnes.

18. **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.

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

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**

(a) **Role**. Basic Jet and Armament Trainer

(b) **Armament**. 2 x 250 kg Bombs or Rocket Pods, 2 x 7.62 mm guns.

(c) Special Features.
Indigenous design of HAL.

27. **HAWK**

(a) **Role**

(b) **Armament**

ADEN cannon, in centerline pod, Bombs, Missiles

28. **PILATUS PC-7**

(a) **Role** 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)**

(a) **Role**. Single Seater Multi Role Combat.

(b) **Armament.** 4000 Kgs (Beyond- Visual-Range missiles, Reconnaissance / Electronic Warfare pods and 23 mm GSH gun.

(c) Performance.

(i) Single engine aircraft expected to be supersonic at all altitude.
(ii) Small size will reduce its chances of detection by enemy radars.

(iii) Capable of Take-off and landing from very short runways.
(iv) Inertial navigation system for accurate navigation and guidance.
(v) Inflight refueling probe for extended range.

(d) Special Features

(i) World's smallest light weight and highly manoeuverable combat aircraft with seven hard-points.

(ii) Developed by aeronautical development agency with contribution from more than 100 government/private agencies.

30. **HAL LIGHT COMBAT HELICOPTER (LCH)**

(a) **Role** The HAL 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.

(b) **Armament** Guns, Hard points: 4 (two under each wing) and provisions to carry combinations of: Rockets, Missiles and Bombs

31. **HAL Dhruv**

(a) **Role** The HAL Dhruv is a utility helicopter developed and manufactured by India's Hindustan Aeronautics Limited (HAL).

(b) **Armament** Missiles: Anti-tank guided missiles, Air-to-air missiles Rocket Pods (Air-Force & Army) Torpedoes, Depth charges or Anti-ship missiles

FOREIGN AIRCRAFT PAKISTAN

32. **F-16**

(a) **Role** Single engine Air Superiority Fighter both for ground attack and Air Defence.

(b) **Armament** 30 mm cannon, laser guided bombs, Air to ground missile, Advanced Medium Range Air to Air missile.

(c) **Special Features.** Highly agile Fighter manufactured by USA.

33. **MIRAGE – 5**

(a) **Role**.Single Seater Ground Attack fighter aircraft.

(b) **Armament - Two 30 mm** cannon and wide variety of air to ground and air to air missiles on seven external stations.

(c) **Special Features.**

□ Manufactured by Dasault Aviation France

34. C - 130 HERCULES

(a) **Role**.Heavy duty transport aircraft. - It can carry upto 92 troops or cargo 45000 lbs

35. SIKORSKY S – 61 (SEA-KING)

(a) **Role**.

Medium Range Lift Helicopter. The Aircraft can Accommodate 26 troops. It can also carry 840 lbs of weapons.

(b) **Special Features.** 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 can be made. Ability and efficiency of see how the use of technology changes the capabilities of a pilot either civil or military. This also shows the superiority of machine over human being in the sense that work beyond the limit where a human being can only imagine. a machine2. Here is the list of modern inventions or equipment that changes the field of aviation. Autopilot, Fly by Wire, UAV, Glass cockpit Technology etc are the gift 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 flights 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 as 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, as in systems that 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.

Power-by-wire

5. The power circuits power electrical or self-contained electro hydraulic actuators that are controlled by the digital flight control computers. All benefits of digital fly-by-wire are retained along with elimination of bulky and heavy hydraulic circuits.

Fly-by-wireless

6. Fly-by-wireless systems are very similar to fly-by-wire systems; however, instead of using a wired protocol for the physical layer a wireless protocol is employed.

UAV

7. 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 or more complex dynamic automation systems. UAVs are currently used for a number of missions, including reconnaissance and attack roles. There are a wide variety of drone shapes, sizes, configurations, and characteristics. 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

8. **Target and Decoy**. Providing ground and aerial gunnery a target an enemy aircraft or missile that simulates aircraft.

9. **Reconnaissance.** Providing battlefield intelligence**.**

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

11. **Research and Development** - used to further develop UAV technologies to be integrated into field deployed UAV aircraft.

12. **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

13. Before 1970's aircraft were not considered 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.

14. The average transport aircraft in the mid- 1970 had more than one hundred cockpit instrument and controls, and the primary flight instrument were already crowded with indicators, crossbars and symbols 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, culminating in a series of flight demonstrating a full glass cockpit system.

15. A glass cockpit is an aircraft cockpit that features electronics instrument displays rather than mechanical gauge .It is as simple as that. 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. They are also popular with airlines companies as they usually eliminate the need for a flight engineer.

Safety

16. As aircraft operation becomes more dependent on glass cockpit systems, flight crews must be trained to deal with possible failure. In one glass cockpit the Airbus A320, fifty incidents of glass cockpit blackout have occurred .In Jan 2008 US Airline flight 731 experienced a serious glass cockpit blackout, losing half of the displays as well as all radios, transponder, and attitude indicator. Glass cockpit blackouts are the main reasons flight training students need to know how to fly with and without electronics instrument displays.

ACQUISITIONS

Rafale

17. Extremely powerful, superbly agile this is a Vth 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 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

18. Indian Air Force formally inducted 4 US made Chinook Heavy Lift Helicopters at Chandigarh. Chinook is tandem rotor Heavy Lift Helicopters 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 heli lift in wide variety of terrain of India. It is the battle proven machine which has flown mission in war zones from Vietnam to Afghanistan & Iraq. Chinook is highly manoeuverable and specially suited for narrow valleys.

S-400

19. 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 stand off jammer Aircraft, Ballistic & Cruise missiles in a dense electronic warfare environment. One S-400 regiment is divided into two battalions. Each battalion consists of 8 launchers and 32 missiles. In addition 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. The missile is capable of exo-atmospheric interception of intermediate range ballistic missile. This system is claimed by Russia to be a full proof Air Defence system and is highly respected by NATO.

SUMMARY

20. 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.

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

22. **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.

23. **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 -V- 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. Gandhiji always made the subtle but significant distinction between nonviolence and cowardice. Hence, when the Pakistan Air Force launched operational against us on the evening of 3rd December, 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 was taken unaware. The briefing officer told newsmen that the raid alert was a genuine one. Soon people realised the seriousness of the situation. The street lights were never switched ON. The cities were plunged into darkness. The AIR then revealed the unfortunate incident of unprovoked aggression by Pakistan.

4. The military junta of Pakistan seem to have chosen the hour of attack with some deliberation and care. The Prime Minister Smt Indira Gandhi was away from New Delhi on days visit to Calcutta, where she had just finished speaking to a large gathering on the Pakistani threat to India's security and the liberation struggle in the Bangladesh. The Defence Minister, Shri Jagjivan Ram was at Patna.

5. 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.

6. In addition to air raids by the Pakistani Air Force the ground forces also launched a massive attack on our border posts.

AGGRESSION ANTICIPATED

7. The professional standards, capability and flexibility of the much expanded Service were soon to be put to the acid test. 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. Mission emphasis throughout was on interdiction. 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, the Indian forces launched a sophisticated campaign which included 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 in the Western desert, four Hunters of the OCU, detachment at Jaisalmer destroyed an entire armoured regiment at Longewala, literally stopping the enemy offensive in its tracks.

8. 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. First round had gone to the Gnats, again, but its later compatriots, the MiG-21s, were to shortly demonstrate the superiority of this supersonic fighter, flown by professionals. Six squadrons of MiG- 21FLs were part of the IAF's order-of battle, participating in operations both in the Eastern and Western Sectors. The the MiG-21 was highly effective in short range, precision attacks was amply demonstrated during the attacks with 500 kg bombs on the PAF's air bases at Tezgaon and Kurmitola, while pin point 57 mm rocket attacks were carried out against key command centres in the capital Dacca itself.

9. 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

10. 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

11. 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.

12. By the second week of May, an ambush on an Indian army patrol acting on a tip- off by a local shepherd 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. The Indian Army moved into the region in full force. Soon, the intruders were found to be well entrenched and while artillery attacks had produced results in certain areas, more remote ones needed the help of the Air force.

Air Operations

13. The Indian Air Force (IAF) was first approached to Provide air support on 11 May with the use of helicopters. On 21 May a Canberra on a reconnaissance mission was hit by ground fire. The flight was however, recovered safely, and 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. Initial indications from the government to the IAF was to operate only Attack helicopters. However, the Chief of Air Staff put forth the argument that in order to create a suitable environment for the helicopters, fighter action was required. 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.

14. 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.

15. 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.

16. 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 steepdive attacks ensuring safety.

17. 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.

Air Marshal Arjan Singh DFC with senior Army Commanders in Kashmir during the 1965 operations.

FAMOUS AIR HEROES

ARJAN SINGH

18. Marshal of the Indian Air Force **Arjan Singh**, DFC was born on 15 April 1919. He is the only officer of the Indian Air Force to be promoted to five-star rank, equal to a Field Marshal, to which he was promoted in 2002. He was born in the Punjab town of Lyallpur, British India, into Aulakh family.

19. **Early Life and Career.** Marshal of the IAF, Arjan Singh was educated at Montgomery, India (now in Pakistan). He entered the RAF College Cranwell in 1938 and was commissioned as a Pilot Officer in December 1939. As a distinguished graduate of the RAF College, Singh's portrait is found on the walls of the College's west staircase.

20. Air Marshal Arjan Singh led No. 1 Squadron, Indian Air Force during the Arakan Campaign in 1944. He was awarded the Distinguished Flying Cross (DFC) in 1944, and commanded the Indian Air Force Exhibition Flight in 1945.

Career and Commands Held

21. He was Chief of the Air Staff (CAS), from 1 August 1964 to 15 July 1969, and was awarded the Padma Vibhushan in 1965. He also became the first Air Chief Marshal of the Indian Air Force when, in recognition of the Air Force contribution in the 1965 war, the rank of the Chief of Air Staff was upgraded to that of Air Chief Marshal. After he retired in 1969 at the age of 50, he was appointed the Indian Ambassador to Switzerland in 1971. He concurrently served as the Ambassador to the Vatican. He was appointed High Commissioner to Kenya in 1974. He was member of the Minorities Commission, Government of India from 1975-1981. He was Lt Governor of Delhi from Dec 1989 - Dec 1990 and was made Marshal of the Air Force in January, 2002. He expired on 16th Sep 2017.

RAKESH SHARMA

22. **Wing Commander Rakesh Sharma**, AC, Hero of Soviet Union, is a former Indian Air Force test pilot who flew aboard Soyuz T-11 as part of the Inter-cosmos program. He was the first Indian to travel in space.

23. **Early Life.** Rakesh Sharma was born on January 13, 1949 in Patiala, Punjab. He joined the Indian Air Force in 1970 as a pilot officer. In the 1971 War, Sharma flew missions in MiG aircraft with considerable success. He was a Squadron leader with the Indian Air Force, when he embarked on a historic space mission.

Spaceflight

24. Sqn Leader Rakesh Sharma, joined two other Soviet cosmonauts aboard the Soyuz T-11 spacecraft

which blasted off on April 2, 1984 as part of a joint space program between the Indian Space Research Organisation and the Soviet Inter cosmos space program, and spent eight days in space aboard the Salyut 7 space station. He did life sciences and materials processing experiments. He is also reported to have experimented with practicing Yoga to deal with the effects of prolonged orbital spaceflight.

25. While in space, he was asked by the then Prime Minister Indira Gandhi on a famous conversation, who asked him how does India look from space, Rakesh replied "Saare Jahan se Achcha Hindustan Hamara" meaning 'Our land of Hindustan, is the Best in the world'.

26. He was conferred with the honour of "Hero of Soviet Union" upon his return from space. The Government of India conferred its highest gallantry award (during peace time), the Ashoka Chakra on him He retired with the rank of Wing Commander. He joined the Hindustan Aeronautics Limited in 1987 and served as Chief Test Pilot in the HAL.

SUMMARY

27. Time to time different heroes have sacrificed for our country, Marshal of Air Force Arjan Singh's contribution during 1965 Indo-China war was recognized by the nation. Wing Commander Rakesh Sharma was the first Indian to travel in space and brought laurels to our country.

CHAPTER - VI- 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 ops. 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 –VII- PRINCIPLE OF FLIGHT

ELEMENTRY MECHANICS

1. "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

2. 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.

LAWS OF MOTION

3. **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).

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

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

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

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

8. **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.

9. **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.

10. **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.

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

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

13. **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 of the said force.

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

15. **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)

16. **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 to the body and the distance moved by that force in the direction in which it is acting. If a force is exerted and no movement takes place, no work has been done.

e.g. (a) Work = Force x Distance (through which the force is applied)

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

e.g. (a) **Power (W) = Force (N) x Distance (m) / Time (s)**

18. **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 those of work, joules.

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

20. **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.

21. **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

22. **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'.

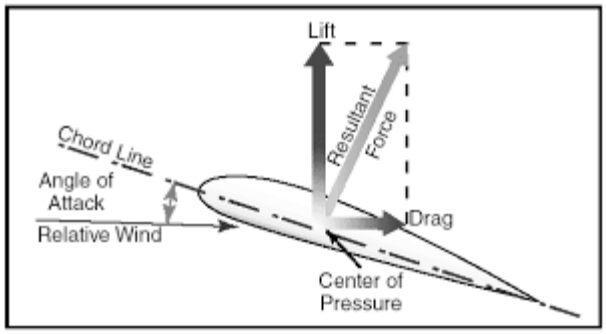
$KE = {}^{1}/_{2}\, m\, V^{2}$ joules

GLOSSARY OF TERMS

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 centres of curvature of leading and trailing edges of an aerofoil.

25. **Chord Length.** It is the length of chord line inctercepted 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 centre 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 angles and in the same direction as the relative airflow.

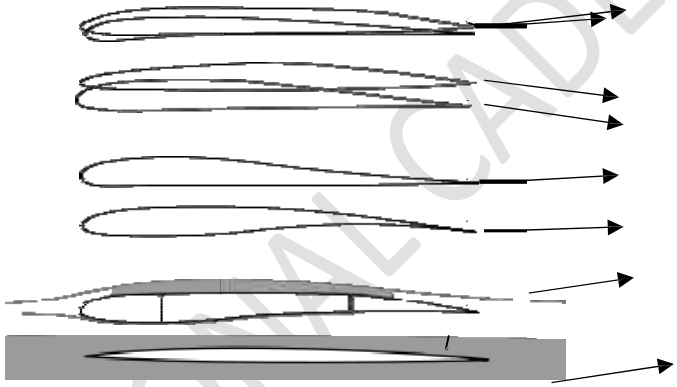
AEROFOIL

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. Subsonic flight airfoils have a characteristic shape with a rounded leading edge, followed by a sharp trailing edge

.

33. 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.



. Laminar flow airfoil for a RC park flyer
- Laminar flow airfoil for a RC pylon racer
- Laminar flow airfoil for a manned propeller aircraft
- Laminar flow at a jet airliner airfoil
- Stable airfoil used for flying wings
- Aft loaded airfoil

  Large allowing for a main spar and late stall
- Transonic supercritical airfoil
- Supersonic leading edge airfoil
-

34. 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. Modern aircraft wings may have different airfoil sections along the wing span, each one optimized for the conditions in each section of the wing. Movable high-lift devices, flaps and sometimes slats, are fitted to aerofoils on almost every aircraft.

SUMMARY

35. 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 –VIII -FORCES ACTING ON AIRCRAFT

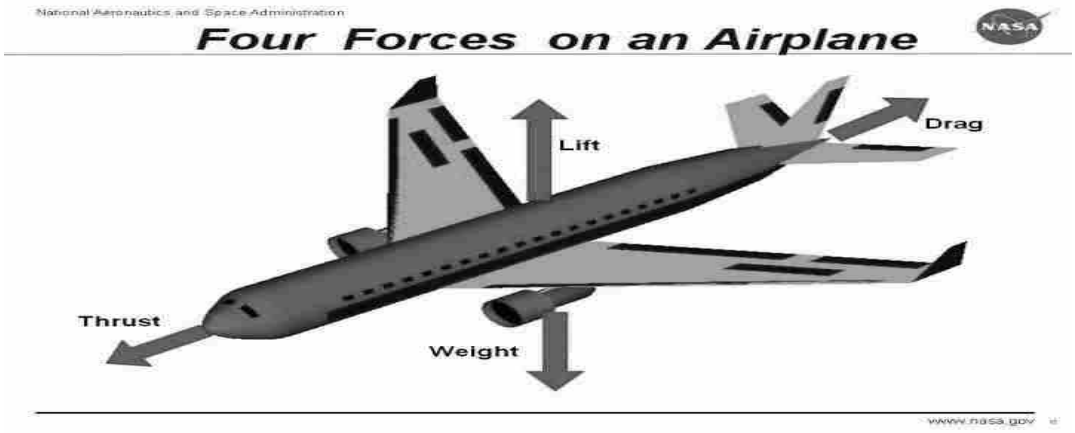
1. An Aircraft is considered to be in straight and level flight when it is flying at a constant altitude and speed, maintaining lateral level and direction. Force acting on aircraft at any given movement are Lift, Drag, Thrust and Weight.

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.

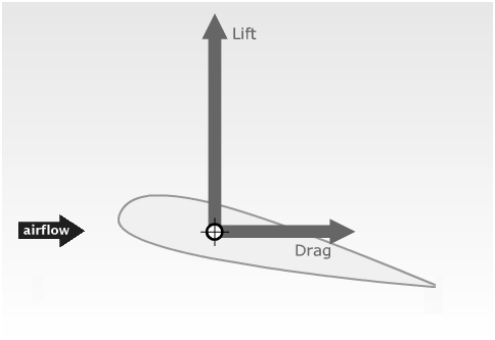
3. **Weight** is the force that causes objects to fall downwards. In flight, the force of weight is countered by the forces of lift and thrust.

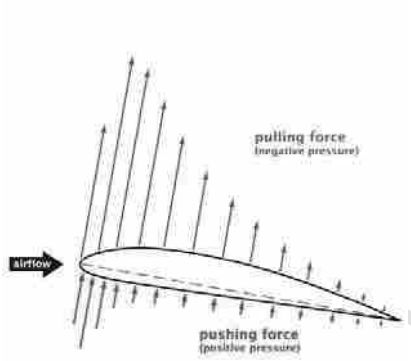
4. **Thrust** is the force that propels an object forward. An engine spinning a propeller or a jet engine expelling hot air out the tailpipe are examples of thrust. In bats, thrust is created by muscles making the wings flap.

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.



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 air craft movement in air.





FLAP & SLATS

"*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 toincrease the angle of descent for landing. They shorten takeoff and landing distances. Flaps do this by lowering the stall speed and increasing the drag.*

6. 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 angle ofattack and speed, so by deploying slats an aircraft can fly at slower speeds, or take off and land in usually 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.

FLAPS

7. The general airplane lift equation:

$$L = \frac{1}{2}\rho V^2 S C_L$$

where:

- □ *L* is the amount of *Lift* produced,
- □ ρ is the air density,
- □ *V* is the indicated airspeed of the airplane or the *Velocity* of the airplane, relative to the air
- □ **S** is the platform area or *Surface area* of the wing
- C_L is the *lift coefficient* which is determined by the camber of the airfoil used, the chord of the wing and the angle at which the wing meets the air (or angle of attack)?

8. Here, it can be seen that increasing the area (S) C_L and lift coefficient (amount of lift to be generated at a lower airspeed (V). Flaps also increase the drag of Aircraft.)

SLATS

9. **Slats**. Slats are like flaps only but extended over the leading edge of the wings.

10. 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 specialist 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.

STALL

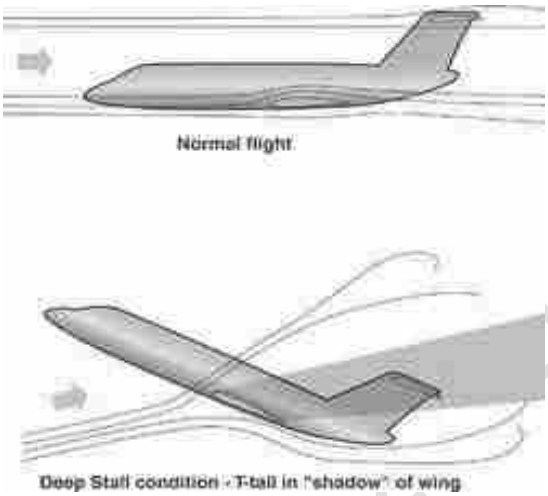
11. A Stall is a reduction in the lift coefficient generated by foil as angle of attack increases. This occurs when the critical angle of attack of the foil is exceeded. The critical angle of attack is typically about 15 degrees, but it may vary significantly depending on the fluid, foil, and Reynolds number. Stalls in fixed-wing flight are often experiencedas a sudden reduction in lift as the pilot increases angle of attack and exceeds the critical angle of attack (which may be due to slowing down below stall speed in level flight). A stall does not mean that the engine(s) have stopped working,or that the aircraft has stopped moving. The effect is the same even in an unpowered glider aircraft.

12. A **Stall** is a condition in aerodynamics and aviation wherein the angle of attack increases beyond a certain point such that the lift begins to decrease. The angle at which this occurs is called the critical angle of attack. This critical angle is dependent upon the profile of the wing, its platform, its aspect ratio, and other factors but is typically in the range of 8 to 20 degrees relative to the incoming wind formost subsonic airfoils. The critical angle of attack is the angle of attack on the lift coefficient versus angle-of-attack curve at which the maximum lift coefficient occurs.

13. Flow separation begins to occur at small angles of attack with attached airflow over the wing still dominant. As angle of attack increases, the separated regions on the top of the wing increase in size and hinder the wing's ability to create lift. At the critical angle of attack, separated flow is so dominant that further increases in angle of attack produce *less* lift and vastly more drag.

14. A fixed-wing aircraft during a stall may experience buffeting or a change in attitude. Most aircraft are designed to have a gradual stall characteristics that will warn the pilot and give the pilot time to react. For example, an aircraft that does not buffet before the stall may have an audible alarm or a stick shaker installed to simulate the feel of a buffet by vibrating the stick fore and aft. The critical angle of attack in steady straight and level flight can be attained only at low airspeed.

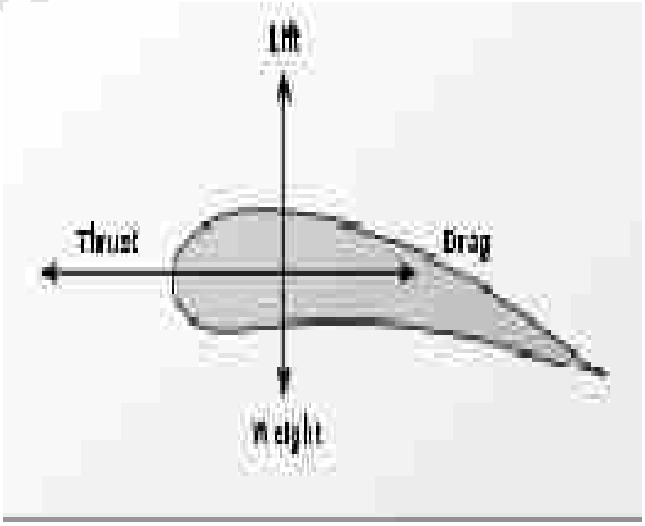
15. **Stalling Speed**. Stalls depend only on angle of attack, not airspeed, however, because a correlation with airspeed exists, **"Stall Speed"** is usually used in practice. It is the speed below which the airplane cannot create enough lift to sustain its weight in flight. In steady, unaccelerated (1g) flight, the faster an airplane goes, the less angle of attack it needs to hold the airplane up (i.e., to produce lift equal to weight). As the airplane slows down, it must increase angle of attack to create the same lift (equal to weight). As the speed slows further, at some point the angle of attack will be equal to the critical (stall) angle of attack. This speed is called the "stall speed". The angle of attack cannot be increased to get more lift at this point and so slowing below the stall speed will result in a descent. Airspeed is often used as an indirect indicator of approaching stall conditions. The stall speed will vary depending on the airplane's weight, altitude, and configuration (flap setting, etc.)



THRUST

16. **Thrust** is a reaction force described quantitatively by Newton's second and third laws. When a system expels or accelerates mass in one direction, the accelerated mass will cause a force of equal magnitude in opposite direction. **Propeller** A propeller converts shaft power from the engine into thrust. It does this by accelerating a mass of air rearwards. Thrust from the propeller is equal to the mass of air accelerated rearward multiplied by the acceleration given toit. A mass is accelerated rearwards and the equal and opposite reaction drives the aircraft forwards

17. **Thrust** is the force which moves an aircraft through the air. Thrust is used to overcome the drag of an airplane. Thrust is generated by the **engines** of the aircraft through some kind of propulsion system.



18. Thrust is a mechanical force, so the propulsion system must be in physical contact with a **working fluid** to produce thrust. Thrust is generated most often through the reaction of accelerating a mass of gas. Since thrust is a force, it is a vector quantity having both a magnitude and a direction. The engine does work on the gas and accelerates the gas to the rear of the engine; the thrust is generated in the **opposite direction** from the accelerated gas. The magnitude of the thrust depends on the amount of gas accelerated and on the difference in velocity of the gas through the engine.

19. Acceleration of Gas produces thrust propelling aircraft forward.

PROPELLER

20. The propeller blade is an aerofoil and the definitions for chord, camber, thickness/chord ratio and aspect ratio are the same as those given previously for the wing. The propeller accelerates a large mass of air rearwards thereby propelling the Aircraft forward.

SUMMARY

24. The flight cadets should thoroughly be conversant with the above basic concepts of level flight for better understanding of aerodynamics.

AIRMANSHIP

CHAPTER IX- VISIT TO AIRFIELD

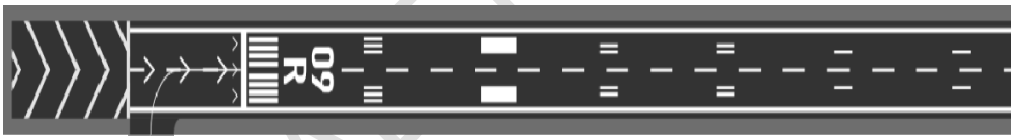
1. **Visit to Airfield-** ATC , Met : Before commencing flying , the cadets need to be taken to ATC & Met Section. At the ATC the cadets are to be shown the Airfield Layout and RT procedures. The basics of meteorology need to be explained at the Met Section for better understanding and assimilation Airmanship is a study of rules and regulations which must be followed both on the ground and in air to ensure safety and proper discipline in flying. It, thus, includes all air traffic control procedures and other actions laid down to deal with any type of aircraft emergencies, and other contingencies

2. **Importance of Airmanship.**

(a) Airmanship helps to inculcate the sense of discipline amongst pilots & other crew members.
(b) It helps the pilot to know the standard procedures laid down for the airfield on which he is operating. It helps the pilot to know procedure to be followed in emergency situation.
(c) Finally, airmanship when studied in correct sense promotes flight safety and prevents aircraft accidents.
(d) Good airmanship ensures a pilot at his best, when the situation is at its worst.

BASIC TERMINOLOGIES

3. **Aerodrome**. Defined area on land or water including any buildings, installations and equipment intended to be used either wholly or in part for the arrival, departure and movement of ac.



4. **Aerodrome Reference Point (ARP).** It is a designated geographical location of an aerodrome, normally taken as the geometrical centre of Runway

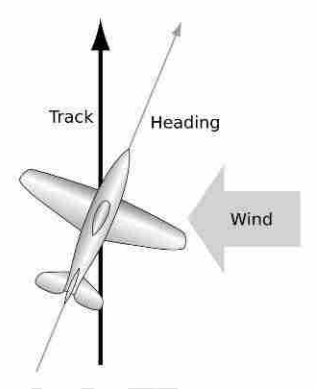
5. **Air Report**. It is a report passed during the course of a flight in conformity with requirements for position, operational, or meteorological reporting in the AIREP or POMAR forms.

6. **Air Route**. The navigable airspace between two points, identified to the extent necessary for the application of flight rules.

7. **Air Traffic Control Centre.** An organisation established to provide:
(a) Air traffic control within a control area (where established).
(b) Flight information service within a flight information region.
(c) Alerting service for search and rescue within its flight information region.

8 . **Air Traffic Control Services.** A service provided for the purpose of:Preventing collisions between ac in the air, and on the manoeuvering area between a/c and obstructions.(Expediting and maintaining an orderly flow of traffic. Air Traffic Control Services are provided by licensed Air Traffic Controllers).

9. **Heading**. The direction in which the longitudinal axis of an aircraft is pointed usually expressed in degrees from North (magnetic).



10. **Height**. The vertical distance of a level, a point or an object considered as a point, measured from a specified datum.

11. **Load Classification Number (LCN)**. The bearing strength of a pavement or runway is defined by a number. This is associated with an indication of the characteristics and type of construction of the pavement

12. **Prohibited Area**. Airspace of defined dimensions, above the land areas of territorial waters of a State, within which the flight of aircraft is prohibited.

13. **Restricted Area.** An airspace of defined dimensions, above the land areas or territorial waters of a State, within which the flight of aircraft is restricted in accordance with specified conditions.

14. **QFE**. Aerodrome pressure corrected for temperature. When set on the altimeter on the ground, the Altimeter should read zero.

15. **Transition Altitude (TA)**. The altitude in the vicinity of an aerodrome at or below which the Vertical position of an aircraft is controlled by reference to altitudes above mean sea level or height above the aerodrome depending on whether QNH or QFE is set on the altimeter.

16. **Transition Layer**. The airspace between the transition altitude and the transition level. The depth of the layer will normally be insignificant, and will in any case never exceed 500 ft.

17. **Transition Level**. The lowest flight level above the transition altitude. It will vary in accordance with the relationship between the QNE and the standard pressure datum.

18. **Visibility**. The ability, as determined by atmospheric conditions and expressed in units of distance, to see and identify prominent lighted objects by night.

19. **QNH**. Aerodrome pressure corrected for temperature and adjusted to Mean Sea Level, using the ICAO formula. When set on the altimeter on the ground, the altimeter should read aerodrome elevation.

20. **Alerting Service.** A service provided to notify appropriate organizations regarding ac in need of search and rescue aid, and assist such organizations as required.

21. **Alternate Aerodrome.** An aerodrome specified in the flight plan to which a flight may proceed when it becomes inadvisable to land at planned aerodrome .

22. **Altitude**. The vertical distance of a level, a point or object considered as a point measured from mean sea level (MSL).

23. **Distress Message**. Emergency message to be used when an aircraft is threatened by

serious or imminent danger and the crew is in need of immediate assistance.

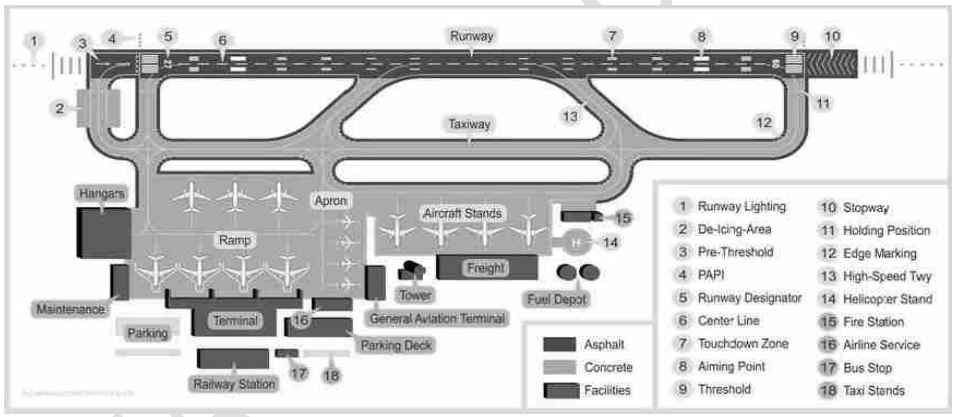
24. **Elevation**. The vertical position of a point or a level, above, on or affixed to the surface of the earth, measured from mean sea level.

25. **Estimated Time of Arrival (ETA).** For IFR flights, the time at which it is estimated that the ac will arrive over a designed point, defined by reference to navigation aids, from which it is intended that an instrument approach procedure will be commenced, or, if no navigational aid is associated with the aerodrome, the time at which the ac will arrive overhead. For VFR flights, it is the time at which it is estimated that the ac will arrive over the aerodrome.

AIRFIELD LAYOUT

26. The sitting, layout and physical characteristics of an airfield should facilitate safe, orderly and expeditious flow of air traffic. The basic are as associated with physical characteristics have been standardised 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 standardised by DGCA conforming to international rules and regulations.

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



28. **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.

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

30. **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.

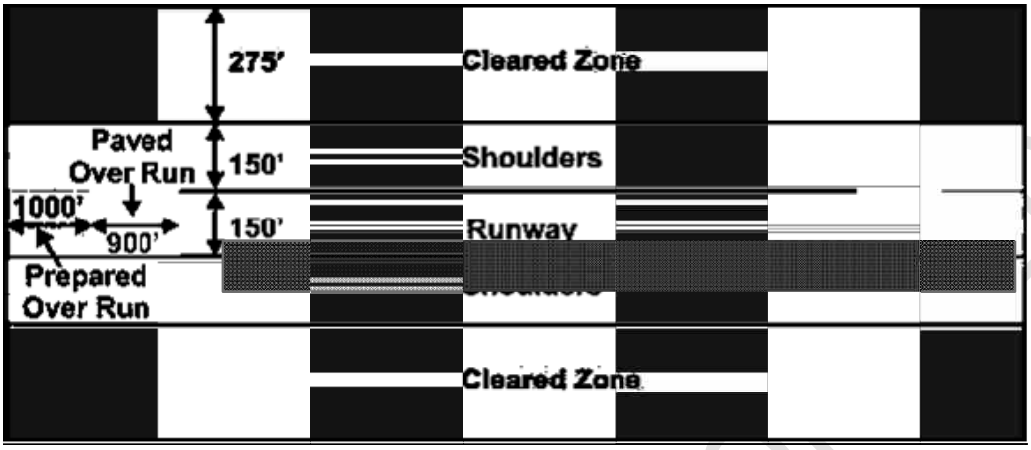
31. **Taxiways.**These are paved surfaces provided for the taxing of aircraft and intended to provide a link between one part of the aerodrome and another.

32. **Shoulders.** Theseare 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.

33. **Cleared Zones**. These are those areas of the flight strip adjacent to the shoulders which for safety

of aircraft operations, should be obstructions as far as possible. levelled and be free of

34. **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.

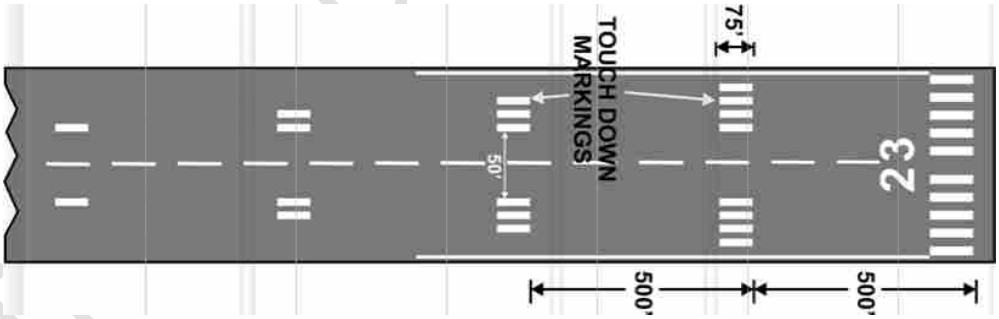


AERODROME MARKINGS

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

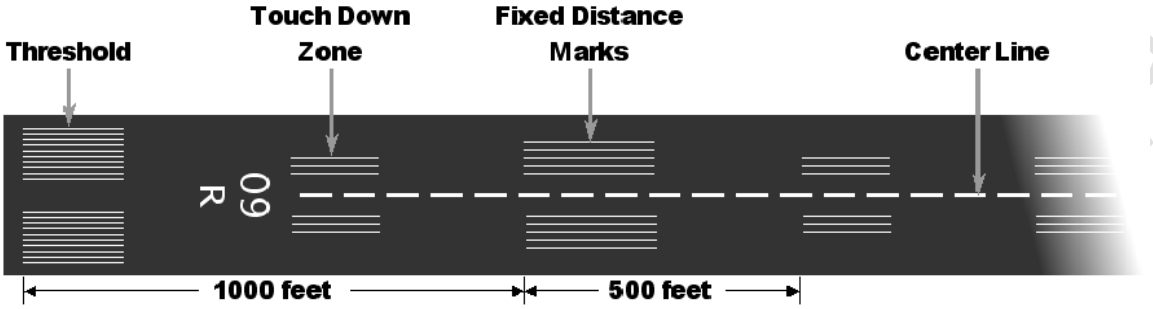
36. Aerodrome ground markings shall consist of the following:

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



37. **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 shall be the whole number nearest to one tenth of magnetic azimuth of centre line measured clockwise from magnetic North when viewed from direction of approach.



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

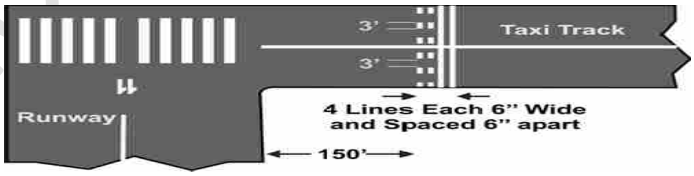
(c) **Runway Threshold Markings.** The markings shall consist of a series of longitudinal strips of uniform dimensions symmetrically placed on both sides of runway centre line and extending laterally to 1.5 m (5 ft) from the edge of runway.

(d) **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.

(e) **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 centre line.

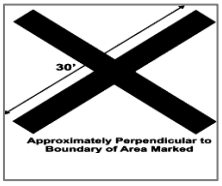
38. **Taxiway Markings.** These markings shall consist of:

(a) **Taxiway Centre Line Markings T**hese markings shall be single unbroken lines 0.15 m (6") wide along the centre 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.



39. **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.

RULES OF THE AIR

40. Flying, in general is of a complex nature, therefore there are many rules and regulations which must be observed by pilots and air traffic control personnel alike if the maximum degree of safety is to be ensured to aircraft, flying personnel, civilians and property.

VISUAL FLIGHT RULES

41. **Visual Meteorological Conditions**. Visual Meteorological Conditions are said to exist when the prevailing visibility, distance from cloud, and ceiling are equal to or better than the specified minimum. In Flight the criteria are:

42.

(a) Visibility: 5 nm / 8 km.

(b) Distance from cloud: 200 yards / 1.5 km horizontally and 1000 feet / 200 meters vertically.

43. **Special VFR Flights**. VFR Flights, specially authorised can be permitted even in weather conditions below VMC, subject to obtaining ATC clearance. Such flights are known as special VFR flights.

44. **Inflight Operation**. VFR Flight shall be flown only in condition of visibility and distance from clouds equal to or greater than those specified for VMC in the laid down orders.

45. **Compliance with Instructions**. VFR flights shall comply with the provisions of ATC services as laid down in general flights rule

(a) When forming part of aerodrome traffic at controlled aerodromes.
(b) When operated as special VFR flights.
(c) When operated in controlled airspace (instrument visual).

46. **Change from VFR to IFR**. A VFR flight when electing to change to IFR shall:-

(a) Communicate the necessary changes to be effected to its current flight plan.
(b) Submit a flight plan to the appropriate ATS unit and obtain clearance prior to changing over the IFR flight when in controlled airspace.
(c) When operated during night with exception of such local flights as may be exempted by the Air Traffic Control. For this purpose, the local flight is wholly conducted in the immediate vicinity of the aerodrome.
(d) When operated more than 100 nm seaward from the coast-line in controlled airspaces.

INSTRUMENTS FLIGHT RULES

47. **Aircraft Equipment**. Aircraft shall be equipped with suitable instruments and with navigational aids appropriate to the route to be flown.

48. **Change from IFR Flight to VFR Flight**. An IFR flight electing to change to Visual Flight Rules, shall notify the appropriate unit, specifically, that the IFR flight is cancelled and communicate the change to be made to its current flight plan.

RIGHT OF WAY RULE

49. The following are some of the basic rules laid down to reduce the risk of collision:-

(a) **Right of way procedure**: Aircraft are to give way to each other in the following orders:-

(i) Aero plane
(ii) Helicopters
(iii) Airships
(iv) Tug and glider combinations
(v) Gliders
(vi) Balloons
(vii) For example, aero planes give way to all other types of aircraft.

(b) **Converging**. When two aircrafts are on the paths which cross, the aircraft which has the other on its right is to give way.

(c) **Approaching Head On**. When two aircrafts are approaching head on, each is to alter heading to the right.

(d) **Overtaking**. An aircraft overtaking another aircraft is to avoid the overtaking aircraft by altering heading to the right, and is to keep clear until all risk of collision is past. Sub para (a) does not apply to this rule. An aircraft is overtaking another aircraft, when it is approaching from the rear at an angle of less than 70 degree to the fore and aft axis of the overtaken aircraft.

(e) **Landing**. Aircraft in the final stage of landing have the right of way over aircraft in the air and on the ground.

(f) **Approaching to Land**. The aircraft at the lower altitude on the approach has the right of way; normally, however, as a matter of courtesy, captains of light maneuverable aircraft give way for the heavier types in which the overshoot procedure is involved.

(g) **Emergency landing**. An aircraft seen, or known to be carrying out an emergency landing has the right of way over all others. Every aircraft obliged by the above rules to keep out of the way of another, is, if possible, to avoid passing over or under the other or crossing ahead of it. The aircraft having the right of way should normally maintain its heading and speed.

CIRCUIT RULES

50. The airfield circuit is the airspace extending to 3,000 ft. above airfield elevation, on a radius of 18,000 ft. from the centre of the airfield. When flying in the circuit, a pilot is to:

(a) Keep a sharp look out for other aircraft in the vicinity.
(b) Conform with or avoid the traffic pattern. Maintain a continuous listening watch on the aerodrome R/T frequencies and keep a sharp look out for any visual signals which may be displayed. Obtain, by R/T or visual means, authorization for any movements.

MINIMUM ALTITUDES

51. Except for taking off and landing, aircraft are not to be flown over built up areas, or assemblies of people, etc. unless at an altitude that would enable them to be landed clear in the event of an emergency landing being necessary. In all cases, their altitude must be such that a minimum height of 2,000 ft above the ground in maintained.

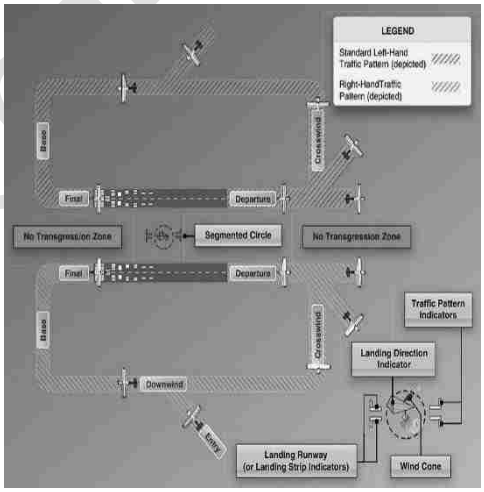
CIRCUIT PROCEDURES

52. A pattern for traffic movement has been established for use at all aerodromes. It is called a **traffic circuit** and it expedites and separates airplanes using the same aerodrome. It is the responsibility of every pilot, for safety and efficiency, to learn and follow the proper traffic procedures when coming in to land at an aerodrome. The cadets are to be shown the circuit procedure in the Flying experience.

TRAFFIC CIRCUIT PROCEDURE

53. The following definitions apply to portions of the traffic circuit:

(a) The **upwind side** is the area on the opposite side of the landing runway from the downwind leg. Approach should be made into this area at or above circuit height.



(b) The **circuit joining crosswind** is a corridor, lying within the airspace between the centre of the landing runway and its upwind end, linking the upwind side and the downwind leg.

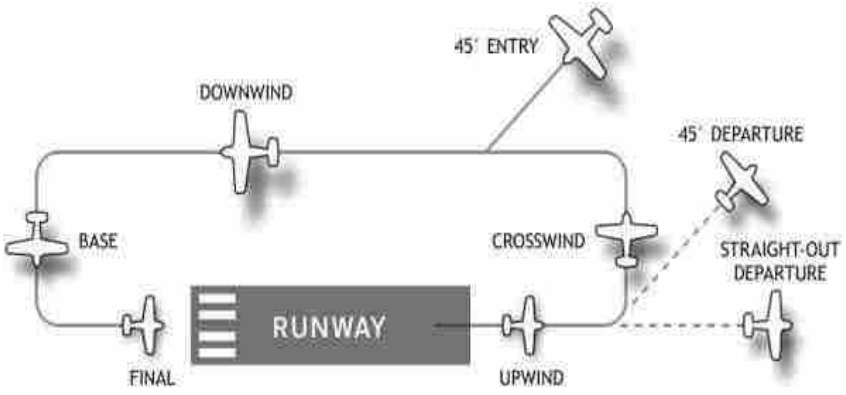
(c) The **downwind leg** is a flight path, opposite to the direction of landing, which is parallel to and at a sufficient distance from the landing runway to permit a standard rate–one turn to the base leg.

(d) The **base leg** is a flight path at right angles to the direction of landing and sufficiently downwind of the approach end of the landing run-way to permit at least a ¼ mile final approach leg after completion of a standard rate –one turn to final approach.

(e) The **final approach leg** is a flight path in the
(f) direction lf landing, commencing at least ¼ mile from the runway threshold, wherein an airplane is in line with the landing runway and descending towards the runway threshold.

THE TRAFFIC CIRCUIT AT CONTROLLED AIRPORTS

54. The traffic circuit consists of the cross wind leg, a downwind leg, a base leg and a final approach leg.



55. Pilot must establish and maintain radio communication with the control tower prior to operating within the control zone served by an operational control tower. You must, therefore, call the control tower on the appropriate frequency prior to entering the control zone, give your identification and position and request landing instructions.

56. The tower controller will advise the runway in use, wind direction and speed, altimeter setting and any other pertinent information and then will clear you to enter the circuit. **"Cleared to the Circuit"** authorizes you to join the circuit on the downwind leg at circuit height. If, because of your position in relation to the runway in use, it is necessary to proceed crosswind prior to joining the circuit on the downwind leg, do so as indicated in above diagram, approaching the active runway from the upwind side at a point midway between each end of the runway staying clear of the approach and departure paths of the active runway .When joining the circuit, you must conform as closely as possible to the altitude, speed and size of the circuit being flown by other traffic.

57. The airport controller may clear you to a straight in approach and in this instance; you may join the traffic circuit on the final approach leg without having executed any other portion of the circuit.

58. Once established in the traffic circuit, you should advise the tower of your position (e.g.**"Foxtrot Romeo Lima Tango is downwind"**).The tower will then give you your landing instructions .For example: Tower**:** Piper Foxtrot Romeo Lima Tango you are number one. Give call on finals Or Tower: Piper Foxtrot Romeo Lima Tango you are number two. Follow Cessna 185 now on base leg.

59. You must have landing clearance prior to landing. Normally, the controller will clear you to land as you turn on to final. If this does not happen, it is your responsibility as pilot to request landing clearance in sufficient time to accommodate the operating characteristic of your airplane. If you do not receive landing clearance, you must pull up and make another circuit. Even after landing clearance is given, the tower may advise you to pull off and go around again if the situation on the runway becomes unsafe for landing. If, after landing clearance is accepted, the situation is such that you, as pilot, feel that there is a hazard to the safe operation of your flight you should advise ATC of your intentions and go around again. Always advise ATC of your intentions.

60. After landing you should clear the runway without delay by continuing forward to the nearest available taxi strip or turn off point. Continue to taxi until you have crossed the taxi position hold line, or until you are at least 200 ft from the runway. You must not exit a runway onto another runway unless authorized by ATC to do so. If you have landed beyond the last turn up point. Proceed to the end of the runway, turn off and wait for permission to taxi back to an intersection. Do not turn and taxi back against the direction of landing traffic unless instructed to do so by the tower. When clear of the active runway, the tower will advise you to switch to ground control who will give you instructions and authorization to taxi to the parking areas.

61. If you are intending to take off from a controlled airport, you must contact ground control for taxi instructions before starting up towards the active runway. Ground control will give you instructions on how to proceed to the active runway and will then advise you to switch to the tower frequency for take-off instructions. When cleared for take-off, you shall acknowledge and take off without delay. Once airborne, remain turned to the tower frequency during the time you are operating within control zone and preferably until you are at least ten miles outside it.

ATC RT PROCEDURE

62. 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

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

64. **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.

65. 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.

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

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

68. **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

SUMMARY

69. The concept of airfields has changed considerably since the early days of flying. The earlier aircraft needed comparatively small, level grass surface. But 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 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, instrumentation and lighting.

70. It is mandatory for all the pilots to follow rules and regulations as given in the relevant publications and amended from time to time. In case the captain of an aircraft experiences circumstances which may lead to an unavoidable violation of ATC regulations he is to inform air traffic control by radio as soon as possible, so that other aircraft may be safeguarded. Air traffic control is also to be informed as soon as regular observance of the regulations can be resumed.

CHAPTER –X- AVIATION MEDICINE

1. Since flying an airplane demands that the pilot be alert and in full command of his abilities and reasoning, it is only common sense to expect that an individual will ensure that he is free of any conditions that would be detrimental to his alertness, his abilities to make correct decisions, and his rapid reaction times before sitting himself behind the wheel of an airplane. Excessive fatigue should be considered a reason for cancelling or postponing a flight.

HYPOXIA

2. The advance in aeronautical engineering in recent years has produced more versatile airplanes capable of flying at very high altitudes. At such high altitudes, man is susceptible to one of the most insidious physiological problems. **Hypoxia** comes on without warning of any kind, supplementary oxygen must be available in any aircraft that will be flown above 10,000 Feet. The general rule of oxygen above 10000 ASL by day and above 5000 ASL by night is essential. Hypoxia can be defined as a lack of sufficient oxygen in the body cells or tissues.

3. The greatest concentration of air molecules is near to earth's surface. There is progressively less air and therefore less oxygen (per unit volume) as you ascend to higher altitudes. Therefore each breath of air that you breathe at, for example, 15000 feet ASL has about half the amount of oxygen of a breath taken at sea level.

4. The most important fact to remember about Hypoxia is that the individual is unaware that he is exhibiting symptoms of this condition. The brain centre that would warn him of decreasing efficiency is the first to be affected and the pilot enjoys a misguided sense of well-being. Neither is there any pain nor any other warning signs that tell him that his alertness is deteriorating. The effects of Hypoxia progress from euphoria (feeling of well-being) to reduced vision, confusions, inability to concentrate, impaired judgment, and slowed reflexes to eventual loss of consciousness.

Effects on Vision at 5000 Feet

5. The first evidence of hypoxia occurs at 5000 feet in the form of diminished night vision. Instruments and maps are misread, dimly lit ground features are misinterpreted.

Above 10000 Feet

6. At 10000 feet, there is a definite but undetectable Hypoxia. This altitude is the highest level at which a pilot should consider himself efficient in judgment and ability. However, continues operation even at this altitude for period of more than, say 4 hours can produce fatigue because of the reduced oxygen supply and a pilot should expect deterioration in concentration, problem solving and efficiency.

7. At 14000 feet, indifference is appreciable. There is dimming of vision, tremor of hands, clouding of thought and memory and errors in judgment. Cyanosis (blue discoloring of the finger nails) is first noticed.

8. At 16000 feet, a pilot becomes disoriented, is belligerent euphoric and completely lacking in rational judgment. Control of the airplane can be easily lost.

HYPERVENTILATION

9. Hyperventilation, or over breathing, is an increase in respiration that upsets the natural balance of oxygen and carbon dioxide in the system, usually as a result of emotional tension or anxiety. Under conditions of emotional stress, fright or pain, a person may unconsciously increase his rate of breathing, thus expelling more carbon dioxide than is being produced by muscular activity. The result is a deficiency of carbon dioxide in the blood.

10. The most common symptoms are dizziness, tingling of the toes and fingers, hot and cold sensations nausea and sleepiness. Unconsciousness may result is the breathing rate is not regulated.

11. The remedy of hyperventilation is a conscious effort to slow down the rate of breathing and to hold the breath intermittently to allow the carbon dioxide to build up to a normal level. Some times, the proper balance of carbon dioxide can be more quickly restored by breathing into a paper bag, that is, by re-breathing the expelled carbon dioxide.

12. The early symptoms of hyperventilation and Hypoxia are similar and may be confused. In fact, both conditions can occur at the same time. A pilot, flying at high altitude may think that he can counteract the effects of Hypoxia by taking more rapid breaths. Hyperventilation does not help you get more oxygen. It only increases the emissions of carbon dioxide. Hypoxia is unlikely to occur below 18000 feet ASL. Above 18000 feet, if oxygen is available, take 3 or 4 deep breath of 100% oxygen. If the symptoms persist, the problem is hyperventilation and should be treated as such.

EAR BLOCK

13. The ear is composed of three sections. The outer ear is the auditory canal and ends at the eardrum. The middle ear is a cavity surrounded by bones of the skull. It houses the organs of hearing and is filled with air. The Eustachian tube connects the middle ear to the throat. The inner ear controls certain equilibrium senses and contains the cochlea, a small organ that analyses sound vibrations.

14. During ascent and descent, air must escape or be replenished through the Eustachian tube to equalize the pressure in the middle ear cavity with that of the atmosphere. If air is trapped in the middle ear, the eardrum stretches to absorb the higher pressure. The result is pain and sometime temporary deafness.

15. The situation is aggravated if the individual has a cold, and allergy or an infected throat. Pilot and passengers must consciously make an effort to swallow or yawn to stimulate the muscular action of the tubes. It is advisable to use the **Valsalva technique**, that is, to close the mouth, hold the nose and blow gently.

FLYING FATIGUE

16. Fatigue is one of the most common psychological problems for air crew members and will adversely affect individuals who are otherwise in good health. It has repeatedly been citied as the casual factor in air plane accident. Fatigue degrades performance. A tired pilot cannot carry out task as reliably and accurately as he should. He is irritable and less alert, willing to accept lower standards of accuracy and performance. Fatigue begins when the pilot begins a flight and increases with each hour in the air.

SUMMARY

17. The purpose of this lecture has been to make the aviators aware of the aeromedical aspects of aviation, importance of oxygen content in the body /Hypoxia, hyperventilation, flying fatigue etc. The most competent, knowledgeable and experienced pilot continue to fly as long as he is medically fit. Maintaining physical fitness is therefore of prime importance.

18. Hypoxia- Hypoxia can be defined as a lack of sufficient oxygen in the body cells or tissues.

19. Hyperventilation- Hyperventilation, or over breathing, is an increase in respiration that upsets the natural balance of oxygen and carbon dioxide in the system, usually as a result of emotional tension or anxiety.

20. Ear Block- Stretching of the ear drum because of blocked air in middle ear.

21. Flying Fatigue- Fatigue is one of the most common psychological problems for air crew members and will adversely affect individuals who are otherwise in good health

CHAPTER –XI- NAVIGATION

1. Air Navigation is the art of guiding an aircraft through the air, so that it arrives at a desired position at a pre-calculated time. Air Navigation differs from surface navigation in several ways such as the aircraft travels at relatively high speeds, leaving less time to calculate their position enroute. Aircraft also normally cannot stop in mid-air to ascertain their position at will.

REQUIREMENTS OF NAVIGATION

2. A number of times Pilot may be called upon to navigate the aircraft himself especially in the aircraft types where no navigator is provided or in a single seat aircraft, Hence a thorough knowledge of the art of navigation is a must for a pilot.

3. Since the pilot has the primary duty of flying the aircraft, it would not be possible for him to carry out the detailed task of a professional navigator in usage of plotting tables, computers, charts etc. He however has to be skilled in map reading and mental DR in order to navigate accurately.

4. Techniques used for air navigation in the air can be broadly classified into two groups.

(a) **Visual Flight Rules (VFR)**. The pilot largely navigates using dead reckoning combined with Visual observations with reference to appropriate maps. This may be supplemented by radio navigation aids.

(b) **Instrument Flight Rules (IFR)**. Under these rules the pilot will navigate exclusively using instruments and radio nav aids such as beacons, or as directed under radar control by a controlling air traffic controller.

5. Before the flight the pilot must take pains to prepare and plan the flight meticulously. For planning he will have to refer to the correct scale of maps, take forecast winds into consideration, plan the cruising altitude, calculate ground speed and time of flight and quantity of fuel required. He also would require to study the various nav aids available at the departure, alternate and destination aerodromes, enroute check points, their frequencies, time of availability etc.

6. Once in flight the pilot must stick to the plan otherwise getting lost is all too easy. This is especially true if flying over featureless terrain or flying in the dark. This means that the pilot must stick to the calculated headings, heights and speeds as accurately as possible.

IMPORTANCE IN AVIATION

7. Apart from map reading and mental DR (mental dead – reckoning) the pilot navigator should also be able to fly the aircraft accurately. Variation in speed, heights and directions often results in unexpected gross errors and place the aircraft quite faraway from the desired track and time. A good pilot will plan a good flight meticulously and fly that good plan.Successful air navigation involves piloting an aircraft from place to place without getting lost, breaking the laws applying to aircraft or endangering the safety of those on board or on ground.

GLOSSARY OF TERMS

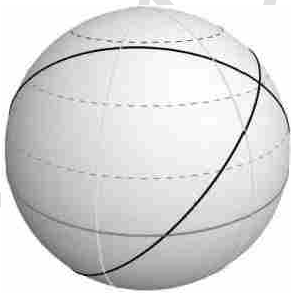
8. In order to simplify Identification and measurement of directions, the earth has been marked by number of imaginary but well defined lines. Over the years, these lines have been recognized and accepted as important symbols by all countries.

LINES ON EARTH

9. The earth is an oblate spheroid whose polar diameter is 23NM less than the equatorial diameter which is 6884NM.Howeverfor the purpose of air navigation on the earth is considered to be a perfect sphere. On this sphere a number of imaginary lines are drawn to understand and simplify air navigation. It is essential to understand these lines before proceeding further in the subject of air navigation.

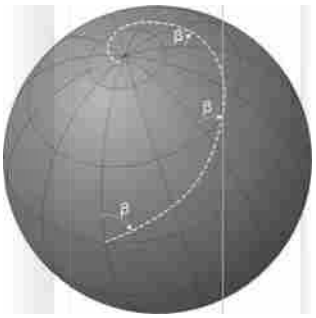
DEFINITIONS

10. **Great Circle.** The circle drawn on the surface of the earth whose plane cuts the earth into two equal halves, eg- the Equator, meridians together with their anti-meridians.

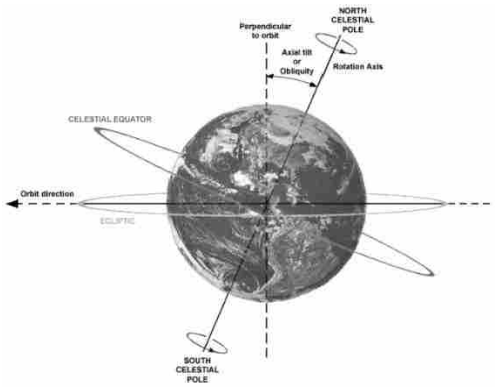


11. **Small Circle**. The circle on the surface of the earth which cuts the earth into two parts which are unequal. It follows that the plane of a great circle always passes through the centre of the earth but that of a small circle does not. e.g.- parallels of a latitude.

12. **Rhumb Line**. The line cutting all the meridians at the same angle. It thus becomes a regularly curved line. examples are the Equator and all the meridians.



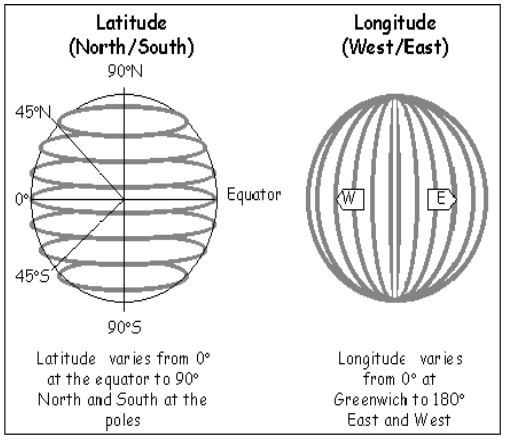
13. **Equator.** It is a great circle whose plane is perpendicular to axis of rotation of the earth. The equator lies in a east-west direction and divides the earth into northern and southern hemispheres.



14. **Earth Axis.** It is a vertical line joining the two poles of the earth, lying perpendicular to the equator and passing through the centre of the earth.

15. **Meridian.** A meridian is a half great circle joining the two poles. Every great circle joining the two poles is a meridian and its ante-meridian indicates the North-South direction. A meridian together with its ante meridian is a great circle.

16. **Latitude**. These are the angular distances along the meridians. The latitude of a place is defined as the arc of its meridian between the equator and the place and is named North or south depending upon its corresponding position in respect to the equator. The latitude is measured in degrees, minutes and seconds form 0° to 90° from the equator.



17. **Longitude.** These are angular distances along the equator on east or west of the prime-meridian. The longitude of a place is defined as the shorter arc of the equator between the meridian of the place and the prime-meridian.It is measured in degrees, minutes and seconds from 0° to 180°along with suffix East or West of the Prime-Meridian.

18. **Prime-Meridian**. The meridian passing through Greenwich Village of England which is the datum for record.

MAPS

19. 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.

TYPES OF MAPS

20. 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

21. 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.

22. **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

23. 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.

24. The beginner is sometimes confused by the amount of detail confronting to 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 types of which is of value to the map reader.

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

SCALES OF MAPS

25. 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.

26. 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.

SUMMARY

27. 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.

CHAPTER XII- INTRODUCTION TO MET AND ATMOSPHERE

1. 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 forecasts and observations forms an integral part of flight planning for safe execution of flight. Meteorological occurrences like thunder storm, snow storm, heavy rains, low visibility, high temperatures, dense fog, wind shear etc have disastrous consequences to conduct of flight. Hence it is mandatory for aviators to be briefed about the likely occurrences of any such phenomena which is likely to endanger a safe flight and take avoidance action.


THE ROBINSON ANEMOMETER.

4. 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.

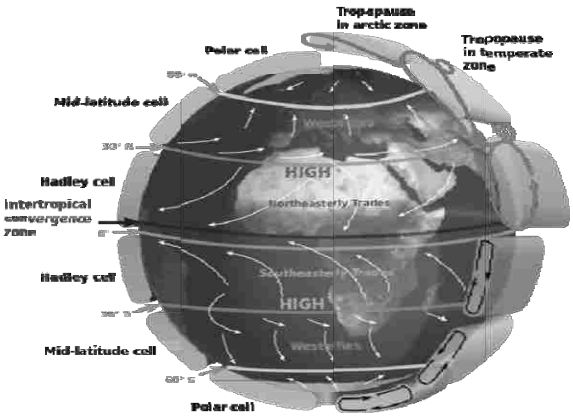
(b) Present state of weather at base and diversionary air fields with emphasis on the aspects that are adverse for flying.

(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.

5. Met briefing always precedes the flight planning stage. Cooperation between met section and aircrew are essential to maintain a high standard of accuracy in forecasting weather.

ATMOSPHERE

6. 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

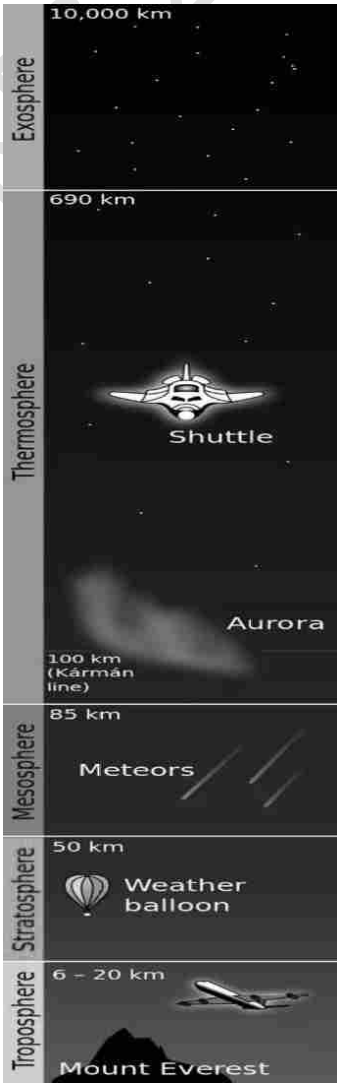
7. Air is a mechanical mixture of a variety of gases. The main constituents of this mixture are nitrogen and oxygen, accounting for almost 99% of the whole, with roughly three parts of nitrogen to one part of oxygen. There are small amounts or traces of other gases. This composition is more or less the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

8. 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 %

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

LAYERS OF ATMOSPHERE



10. 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)	Stratophere-	Up to about 50 km above troposphere
(c)	Mesosphere	50 to 85 km
(d)	Thermosphere	above 85 km

Troposphere.

11. 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.

12. 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.

13. 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 temperatures in the atmosphere is found (about - 90°c).

Thermosphere.

14. 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.

15. 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.

16. A standard average atmosphere has to b e 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 pressure1013.25 mb

(c) Surface density1225 g/m3

(d) Acceleration due to gravity980.665 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

17. Pressure as weight of the air above: 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 per square inch etc. like millibars, pounds 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).

18. **Layers of Atmosphere**

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

CLOUDS AND PRECIPITATION

19. Clouds and precipitation are major aviation weather hazards and need to be well understood. From a brief observation of the sky two fundamental characteristics of clouds become apparent. Their infinite variety of form and their continual change in appearance. The study of the cloud is one of the fascinating aspects of weather science and important tool of weather forecasting. Clouds form in the sky, develops, take different shapes and dissolve. Each process is an indication of some physical state in the atmosphere

CLOUDS

20. The clouds may be defined as visible aggregate of minute particles in the of water free air. or ice or Clouds both are Formed by cooling of masses of damp air, generated by upward motion and its accompanying expansion with fall of pressure. The essential difference between clouds of various forms or types are due to their varying nature of the ascending produces them. motion which The Ascending motions which may be effective in producing clouds may be classified in the fol owing manner.

(a) Turbulent motion, leading to numerous small scale upward currents.
(b) Uphill currents over sloping grounds.
(c) Large scale convection as a result of surface heating.
(d) Currents of warm moist air moving upward over a wedge of cold air and cold air acting in the same way as the sloping ground cited above.

CLASSIFICATION OF CLOUDS

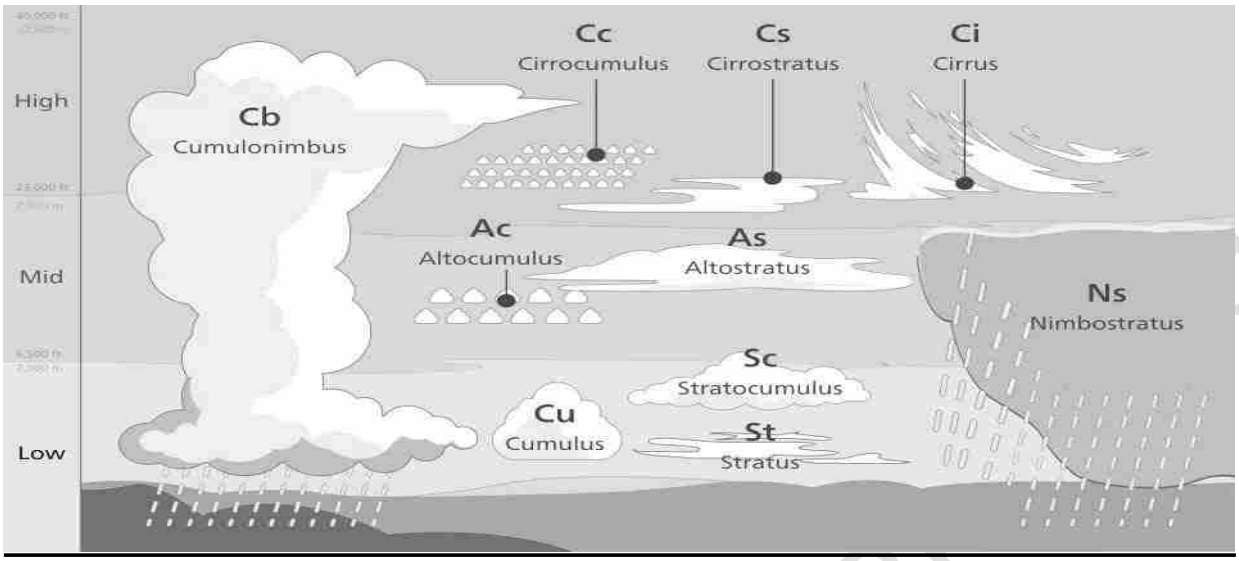
21. The number of forms which clouds may take, is almost infinite, but for the purpose of description, it is necessary to adopt some kind of classification. The system of classification which have been proposed, have sometimes been based on the observed appearance of the clouds and at the other times on the supposed method of formation. There can be no doubt that the former is the correct method since an observer is able to judge definitely the appearance, whereas, the method of The formation must be, to some extent, a matter of opinion.

Class of family	Average height	Forms
High Clouds	20,000 feet and above	Cirrus, Cirro-Stratus, Cirro-cumulus
Medium Clouds	6500 feet to 20,000feet	Alto-Stratus,Alto-Cumulus,
Low Clouds	Ground level to 6500 feet	Stratus, Strato-Cumulus.
Clouds with vertical development but tops reaching high and medium cloud levels	Base 1500 feet to 6500 feet	Cumulus, Cumulo-Nimbus.

22. The international cloud classification is based upon the appearance of clouds and consists of four families of classes depending upon the heights at which they form. Each class is further sub-divided into two or three forms according to their appearance.

Significance of Prefixes and Suffixes

23. Cirrus or prefix ‘Cirrro’ means high clouds, prefix alto means medium clouds,stratus means layer type and cumulous means heap type.



PRECIPITATION

24. Precipitation is the general term used for drizzle, rain, shower, sleet and snow i.e. water droplets or ice crystals falling from clouds.

TYPES OF PRECIPITATION

25. Water droplets or ice crystals in a cloud are usually of such small dimension that they are kept suspended in mid- air by the vertical current at the base of the cloud. These vertical currents are a necessary contribution for the formation of clouds and their maintenance. For the water droplets or ice crystal to overcome the vertical currents and fall under the force of gravity, their diameter should be of the order at least a millimeter or more.

(a) Drizzle. Minute water drops falling from the clouds. The drops are so small that they look like spray and are at times blown and carried by wind.

(b) Rain. Medium size water drops falling from layer types of clouds.

(c) Snow. Frozen rain in the form of flakes or ice crystal.

(d) Sleet. Mixture of rain and snow.

(e) Shower. Large drops falling from heap type of clouds.

(f) Thunder storm. A phenomenon in which thunder is heard and lightning is seen. Generally accompanied by sharp shower. They are associated with Cb clouds.

(g) Hail storm. A storm in which solid pellets of ice fall on the ground.

SUMMARY

26. Many Flying accidents can be attributable to flying in clouds and through heavy precipitation. Apart from disorientation it causes difficulty in judgment & controllability of aircraft. Under such conditions it is always wise to avoid or divert the aircraft to a suitable base reporting good weather.

CHAPTER XIII- INTRODUCTION AND TYPES OF AERO ENGINES

1. An engine is a device where-in energy in one form is converted into another form. Here the heat energy is converted into mechanical energy to produce required propulsion. The propulsion is achieved by imparting acceleration to a certain mass of gas as per Newton's third law of motion.

BASIC THEORY

2. Aero-engines are machines which transform the potential energy contained in fuel and air either into kinetic or mechanical energy. The gas energy is produced by the combustion of an air-fuel mixture. The forward thrust is produced as per Newton's third law which states that '**for every action, there is an equal and opposite reaction**.' The operating cycle (pressure / volume cycle) of a basic aero-engine is **Brayton cycle**.

3. **Types of Propulsion**

(a) **Direct Reaction Propulsion**.

(i) In the case of **rockets and ram-jets**, all the gas kinetic energy is used for propulsion.

(ii) In the case of turbo-**jets**, the gas kinetic energy is partially used for propulsion, the rest is transformed into mechanical energy.

(b)_ **Indirect Reaction Propulsion**. In this case, the gas kinetic energy is almost transformed into mechanical energy. Eg: - **Turbo shaft and Turbo prop engines**.

COMPONENTS OF AERO ENGINES

4. **Operating Phases**. There are basically five operating phases for any Aero-engine. They are as follows:-

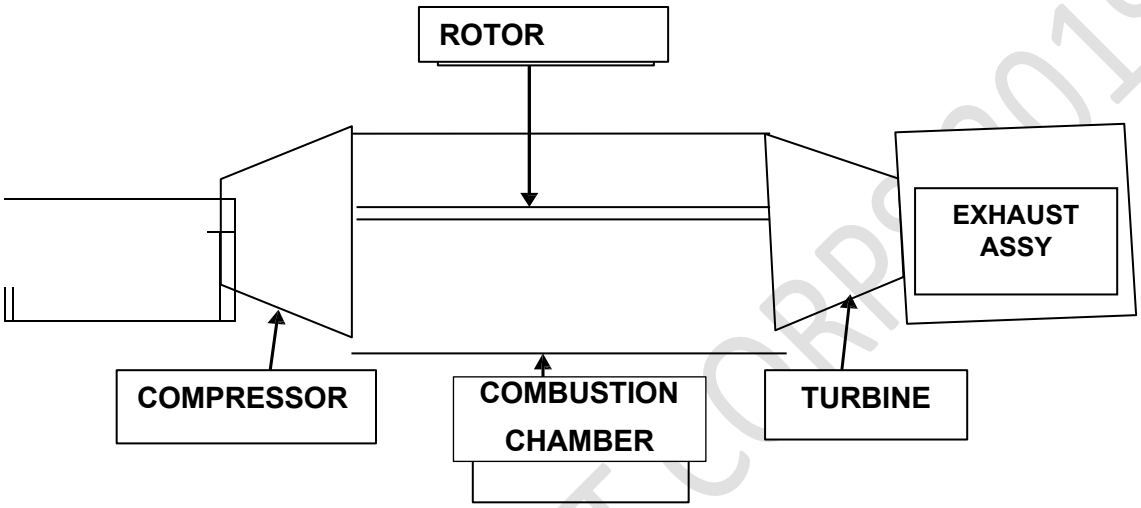
(a) Induction
(b) Compression
(c) Combustion
(d) Expansion
(e) Exhaust

5. In an Aero engine, the operating phases are achieved with the help of following components:

(a) Air intake		Assists in induction of air
(b) Compressor		Assists in compression of air
(c) Combustion chamber	:	Assists in combustion of fuel and air
(d) Turbine assembly	:	Assists in expansion of combustion gas
(e) Exhaust assembly	:	Assists in exhaust of gas

6. Apart from above, aero-engine has mounted components on the engine such as Fuel pump, Oil pump, Vacuum pump, Booster pump, Generator etc. In case of four stroke engine used on small aircraft, magneto and carburetor would be fitted on the engine.

7. The figure below is the schematic diagram to illustrate the main operating phases of the aero-engine components



TYPES OF ENGINES

8. There are various types of engines in use today such as Heat engines, Electric motors, Generators, Hydroelectric turbines and Wind mills. However, in the field of aviation, heat engines are of great relevance. Heat engines are devices which convert heat energy into mechanical energy.

PRINCIPLES OF PROPULSION

9. The propulsion of aircraft is achieved by imparting acceleration to a certain mass as per Newton's third law of motion. The relation between the force '**F**' and the acceleration '**a**' imparted to the mass '**m**' is **F = ma**

10. There are two types of propulsion. They are as follows:-

(a) **Propulsion By Action**. It consists of rotating a propeller in the air so as to create aerodynamic forces and to accelerate the mass of air. In this type of propulsion, a great mass of air is expelled rearwards with a low increase of speed. This is what a propeller does on the aircraft.

(b) **Propulsion By Reaction**. In this case, the forward force is produced by expelling a mass of gas with a certain speed. In this type of propulsion, a small mass of air is expelled rearwards with a great acceleration. This is the principle of je t propulsion. If '**m**' is the mass flow of gas with '**V1**' as inlet velocity and '**V2**' as outlet velocity, then forward force '**F**' is given by '**F**' = **m** (**V2- V1**)

(c) **Indirect Reaction Propulsion**. In this case, the gas kinetic energy is almost transformed into mechanical energy. Eg: - **Turbo shaft and Turbo prop engines**.

JET ENGINES

11. Gas turbine engines are divided into two main classes. They are Turbo jet engine and Turbo prop engine. Almost all the modern aircraft including military aircraft are powered by this class of engines.

BASIC THEORY

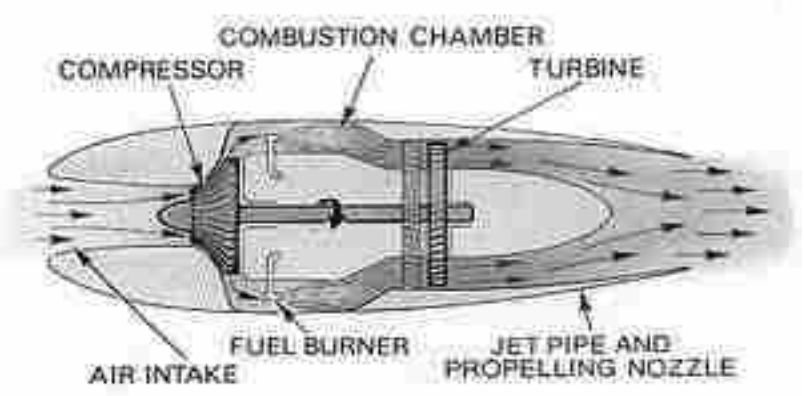
12. The principle of operation of a jet engine is similar to a piston engine in that the processes such as induction,, compression, ignition and exhaust are the same. The main difference from piston engine is that in case of a jet engine, the processes are continuous and not intermittent which is the case with a piston engine.

13. The ambient air enters the engine through the air intake. This air is then compressed by a multi- stage axial compressor. The combustion is achieved in an annular chamber. Gases are expelled at a high velocity, which creates the required thrust.

14. As explained, whatever the propulsion mode may be, the operating phases are similar. In a gas turbine, these phases are achieved with the following elements:-

(a) Air intake
(b) Compressor
(c) Combustion chamber
(d) Turbine
(e) Exhaust

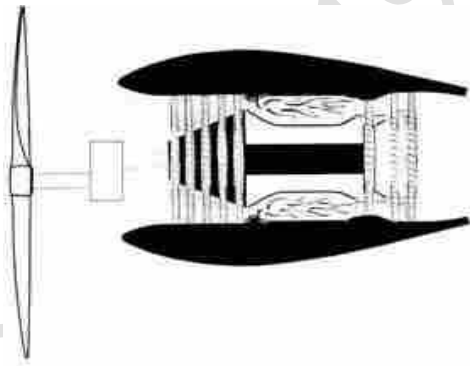
15. The thrust produced in a jet engine can be mathematically shown. If '**m**' is the mass flow of gas with '**V1**' as inlet velocity and '**V2**' as outlet velocity, then forward thrust '**F**' is given by '**F**' = **m** (**V2-V1**). A basic jet engine is shown below.



TURBO PROP ENGINE

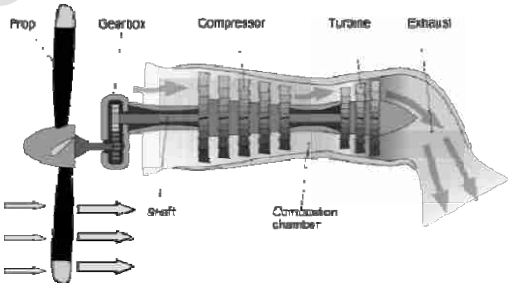
16. Turbo prop engine is a gas turbine engine which supplies mechanical energy to a propeller/set of propellers for producing the required thrust.

THEORY



17. The gas turbine engine that is used to drive a propeller as shown above is called a turbo prop engine .A turboprop engine is simply a turbine engine where a propeller is attached to the low-pressure rotor at the front, via a gearbox. The air that passes through the propeller near its inner diameter also passes through the compressor stages in the core of the engine and is further compressed and is processed through the engine cycle. The air that passes through the outer diameter of the propeller does not pass through the core of the engine ,but instead passes along the outside of the nacelle. The large volume of air pushed backward by the propeller provides airplane thrust in the same way as the smaller, high velocity air from the nozzle of a classic jet engine.

TYPES OF TURBO PROP ENGINES



18. There are two types of turbo prop engines:
   (a) Single shaft engine
   (b) Free turbine engine

19. The main difference between single shaft and free turbine engine is in the transmission of power to the propeller.

(a) **Single Shaft**. In a single-shaft engine, the propeller is driven by the same shaft (spool) that drives the compressor. Because the propeller needs to rotate at a lower RPM than the turbine, a Reduction gear box reduces the engine shaft rotational speed to accommodate the propeller through the propeller drive shaft.

(b) **Free Turbine**.In a free-turbine engine, the propeller is driven by a dedicated turbine. A different turbine drives the compressor; this turbine and its compressor run at near-constant RPM regardless of the propeller pitch and speed. Because the propeller needs to rotate at lower RPM than the turbine, a reduction gearbox converts the turbine RPM to an appropriate level for the propeller.

SUMMARY

20. In any engine the basic working principle remains the same, Also the mode of accomplishing the operating phases and the gas flow through different aero-engines more or less remains the same. The thermodynamic cycle for the operation of a basic aero-engine is Brayton cycle. However, the performance characteristics vary with varying designs of its assemblies by different manufactures.

CHAPTER XIV-AIRCRAFT CONTROLS

Note The Cadets should be demonstrated about the aircraft controls and other aircraft parts on the Microlight itself for better understanding.

1. A conventional wing aircraft flight control system consists of flight control surfaces, the respective cockpit controls, connecting linkages, and the necessary operating mechanisms to control an aircraft's direction in flight. Aircraft engine controls are also considered as flight controls as they change speed. Generally basic aircraft control can be classified as follows:

(a) Primary controls
(b) Secondary controls

BASIC AIRCRAFT CONTROLS

2. The basic aircraft controls are classified in to following:

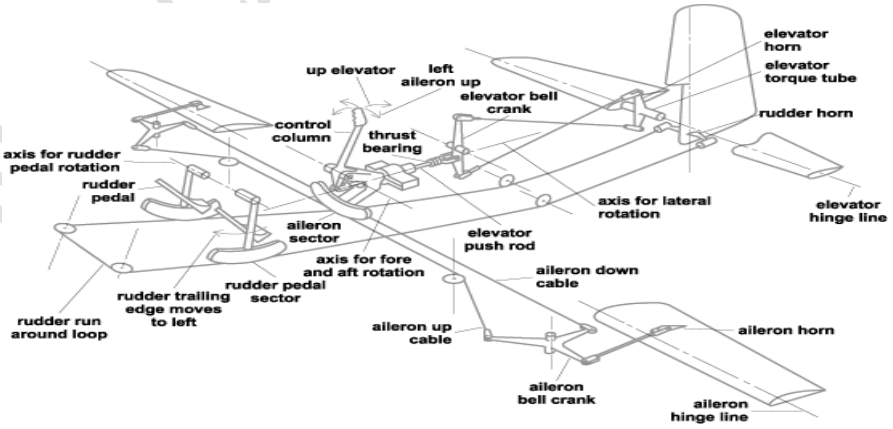
(a) **Primary Controls**. Basically the primary aircraft controls are arranged as follows:

(i) A control yoke (also known as a control column), centre stick or side-stick governs the aircraft's roll and pitch by moving the ailerons, when turned or deflected left and right, and moves the elevators when moved backwards or forwards

(ii) Rudder pedals, to control yaw, which move the rudder; left foot forward will move the rudder left for instance.

(iii) Throttle controls to control engine speed or thrust for

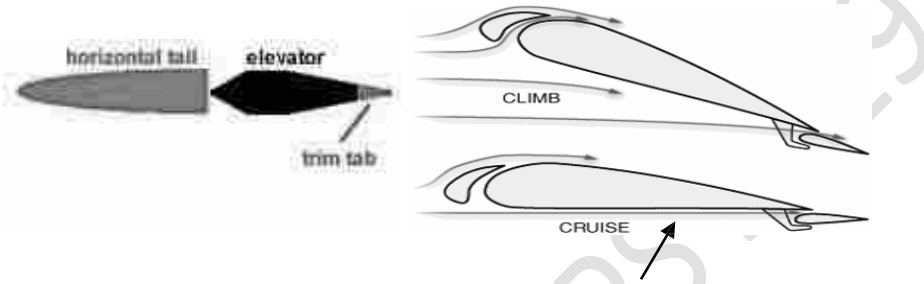
powered aircraft.



(b) **Secondary Controls**. The secondary controls are trim tab, flap (aircraft), Air brake (aircraft), Spoiler , Leading edge slats, and variable-sweep wing.

(i) **Trim Tabs**. These are small control surfaces connected to the trailing edge of a larger control surface of aircraft, used to control the trim of the controls, i.e. to counteract aerodynamic forces and stabilise the aircraft in a particular desired attitude without the need for the operator to constantly apply a control force. This is done by

adjusting the angle of the tab relative to the larger surface. Changing the setting of a trim tab adjusts the neutral or resting positionof a control surface (such as an elevator or rudder). As the desired position of a control surface changes (corresponding mainly to different speeds), an adjustable trim tab will allow the operator to reduce the manual force required to maintain that position.



(ii) **Air brakes and Spoilers**. Air Brakes or speed brakes are a type of flight control surface used on an aircraft to increase drag or increase the angle of approach during landing. Spoilers are designed to increase drag while making little change to lift. Thus, spoilers reduce the lift-to-drag ratio and require a higher angle of attack to maintain lift, resulting in a higher stall speed. Most gliders are equipped with spoilers on the wings in order to adjust their angle of descent during approach to landing.

(iii) **Slats**. 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 angle of attack and speed, so by deploying slats an aircraft can fly at slower speeds, or take off and land in shorter distances. They are usually used while landing or performing maneuvers which take the aircraft close to the stall, but are usually retracted in normal flight to minimize drag.

(iv) **Variable - Sweep Wing**. A variable-**sweep wing**, also known as"swing wing", is an aeroplane wing that may be swept back and then returned to its original position during flight. It allows the aircraft's plan form to be modified in flight, and is therefore an example of a variable-geometry aircraft.

(v) **Flaps**. 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 increasethe angle of descent for landing. They shorten take-off and landing distances. Flaps do this by lowering the stall speed and increasing the drag.

FUSELAGE

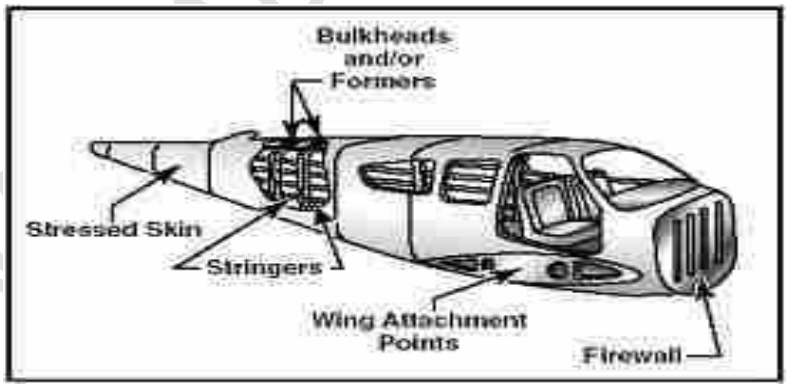
3. Fuselage is the main body of the aircraft to which all the other components are attached. It also contains the cockpit from where the pilot controls the aero-plane. It provides the space for the freight and passengers.

BASIC DESIGN

4. 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.

5. 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

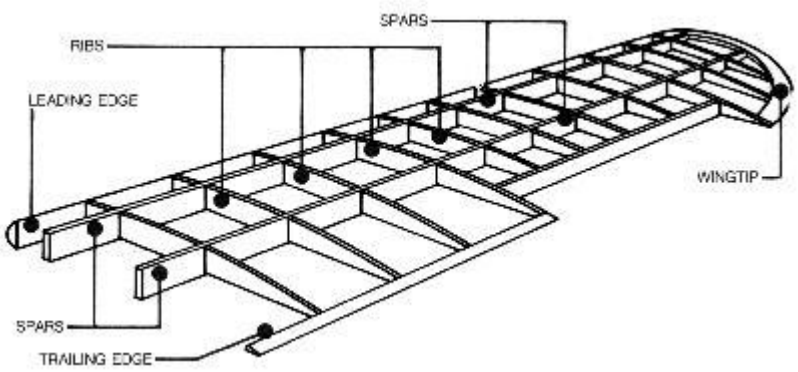
6. Early aircraft were constructed of wood frames covered in fabric. As monoplanes became popular, metal frames improved the strength, which eventually led to all-metal aircraft with metal covering all surfaces. Some modern aircraft are constructed with composite materials for major control surfaces, wings, or the entire fuselage such as the Boeing 787. On the 787, it makes possible higher pressurization levels and larger windows for passenger comfort as well as lower weight to reduce operating costs. Hence the various types of materials can be classified as follows:

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

MAIN /TAIL PLANE AEROLONS ELEVATORS & RUDDERS (AA-7)

7. 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.

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, or through another gaseous or liquid fluid. 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:

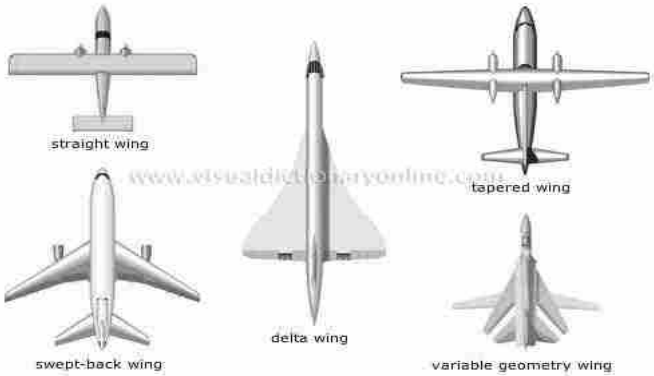
(a) Straight wing

(b) Swept back wing

(c) Delta wing

(d) Tapered wing

(e) Variable geometry wing



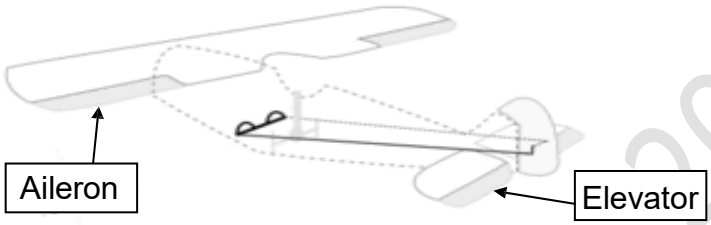
AILERONS, ELEVATORS AND RUDDERS

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 below shows the position of Aileron and Elevator on an aircraft.



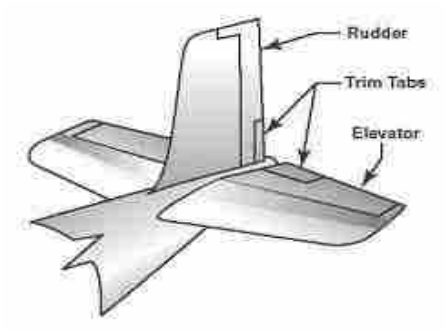
12. Ailerons are mounted on the trailing edge of each wing near the wingtips and move in opposite directions. When the pilot moves the stick left, or turns the wheel counter-clockwise, the left aileron goes up and the right aileron goes down. A raised aileron reduces lift on that wing and a lowered one 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 and begin to turn to the left. Centering
the stick returns the ailerons to neutral maintaining the bank angle. The aircraft will continue to turn until opposite aileron motion returns the bank angle to zero to fly straight.

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. This makes the wings fly at a higher angle of attack, which generates more lift and more drag. Centering the stick returns the elevators to neutral and stops the change of pitch. Many aircraft use a stabilator — a moveable horizontal stabilizer — in place of an elevator. Some aircraft, such as an MD-80, use a servo tab within the elevator surface to aerodynamically move the main surface into position. Thedirection of travel of the control tab will thus be in a direction opposite to the main control surface. It is for this reason that an MD-80 tail looks like it has a 'split' elevator system.

RUDDER

14. A typical view of Rudder is shown below.



15. The rudder is a fundamental control surface, typically controlled bypedals rather than at the stick. It is the primary means of controlling yaw-the rotation of an airplane about its vertical axis. The rudder may also be called upon to counter-act the adverse yaw produced by the roll-control surfaces.

16. 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. The rudder's direction in aircraft has been manipulated with the movement of a pair of foot pedals by the pilot.

SUMMARY

17. 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, elevens, flaps and flaperons into wings to perform the aerodynamic purpose with the advantages of less mass, lower cost, reduced drag and inertia (for faster, stronger control response).

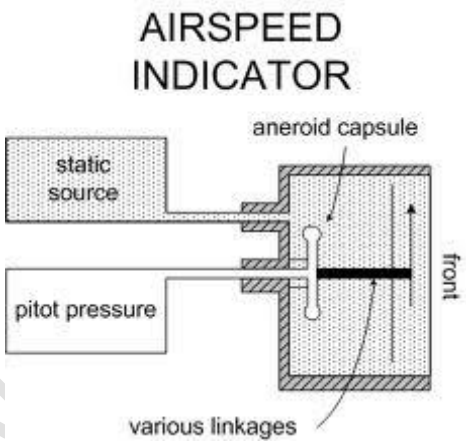
CHAPTER XV- BASIC FLIGHT INSTRUMENTS

1. The best medium for flying an aircraft is the natural horizon. It is the place where the earth and the sky seem to meet. But during cloudy conditions and at night, the horizon is not visible. During such occasions, the instruments of an aircraft play a very vital role in aiding the pilot to fly the aircraft safely. As flying involves the third dimension, instruments become very important. The instruments also give out the health of the engine and re-assure the pilot that all vital parameters of flying are within the prescribed limits.

AIR SPEED INDICATOR

2. The airspeed indicator is an instrument used in an aircraft to display the craft's airspeed to the pilot. The principle of an Air Speed Indicator is the measurement of two pressures called static and pitot pressures.

3. If an open ended tube is moved through the air, pressure will be exerted at the closed end of the tube. This pressure has two components- static and the dynamic. The static pressure is due to the pressure exerted by the atmosphere and the dynamic is due to the movement of the tube through the air. The total pressure is known as pitot pressure. the dynamic pressure is indicated in terms of speed of the aircraft. The dynamic pressure is calculated as: Dynamic = Pitot – Static



Internal Mechanism of An Airspeed Indicator

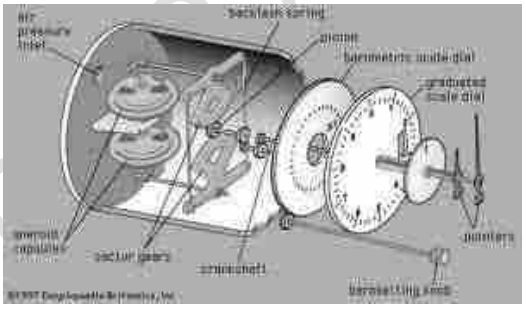
4. This instrument uses an open ended capsule fixed inside an airtight case. The open end is connected to pitot pressure. Static pressure is fed inside the case. The static pressure remaining constant in the entire case, the variation is only in the pitot pressure due to the movement of the aircraft in air. The capsule accordingly expands or contracts and this variation is calibrated in terms of speed.

ALTIMETER

5. An altimeter is an instrument used to measure the altitude of an object above a fixed level usually the sea level. The altimeter shows the aircraft's altitude above mean sea- level. Altitude can be determined based on the measurement of atmospheric pressure.

6. The atmosphere has weight and this weight exerts pressure. This is known as static pressure. This pressure reduces with height at the rate of 1 millibar / hectapascal per 30 feet approximately.

7. An aneroid barometer is used to measure the atmospheric pressure. An aircraft altimeter is simply an aneroid barometer adapted to use in aircraft calibrated to read the atmospheric pressure in terms of height. This is done by measuring the difference between the pressure in a stack of aneroid capsules inside the altimeter and the atmospheric pressure obtained through the static system. As the aircraft ascends, the capsules expand and the static pressure drops, causing the altimeter to indicate a higher altitude. The opposite effect occurs when descending.



8. The altimeter has two or three capsules each having vacuum or partial vacuum in them. They are stacked together with one end fixed firmly down. There are three pointers to indicate height in 100s ,1000s and 10,000s feet.

9. The whole assembly is encased in a container having an inlet for the static pressure but otherwise is airtight.
The movement of the capsules in response to the variation in the pressure due to variation of height is transmitted to the pointers which indicate the height on the dial.

ARTIFICIAL HORIZON

10. The artificial horizon shows the aircraft's attitude relative to the horizon. From this, the pilot can tell whether the wings are level and if the aircraft nose is pointing above or below the horizon. This is a primary instrument for instrument flight and is useful in conditions of poor visibility. An artificial horizon is an instrument used in an aircraft to inform the pilot of the orientation of the aircraft relative to earth. It indicates pitch (fore and aft tilt) and bank or roll (side to side tilt).

11. The essential components of the indicator are “miniature wings", horizontal lines with a dot between them representing the actual wings and nose of the aircraft:-

(a) The centre horizon bar separating the two halves of the display, with the top half usually blue in color to represent sky and the bottom half usually dark to represent earth.

(b) Degree marks representing the bank angle. They run along the rim of the dial. On a typical indicator, the first 3 marks on both sides of the center mark are10 degrees apart. The next is 60 degrees and the mark in the middle of the dial is 90 degrees. If the symbolic aircraft dot is above the horizon line (blue background) the aircraft is nose up. If the symbolic aircraft dot is below the horizon line (brown background) the aircraft is nose down. it is the horizon that moves up and down and turns, while the symbolic aircraft is fixed relative to the rest of the instrument panel. Artificial Horizon uses a vertical axis earth gyroscope having freedom in all three planes to indicate the aircraft's attitude in pitch and roll. The gyroscope is geared to a display simultaneously displaying pitch and bank. The display is coloured to indicate the horizon as the division between the two coloured segments, blue for sky and brown for ground.

SUMMARY

12. During this period, the basic three instruments have been covered to understand their use and functioning. One must remember that the instruments play a very vital part in helping the pilot to fly an aircraft. The height above the mean sea level, the condition of flight and the speed of the aircraft can thus be known by the pilot by monitoring the instruments.

CHAPTER XVI- INTRODUCTION TO RADARS

1. Radar was secretly developed by several nations before and during World War II. The term RADAR was coined in 1940 by the United States Navy as an acronym for Radio Detection and Ranging. The term radar has since entered English and other languages as the common noun radar, losing all capitalization.

2. The modern uses of radar are highly diverse, including air traffic control, radar astronomy, air-defence systems, antimissile systems; marine radars to locate landmarks and other ships; aircraft anti-collision systems; ocean surveillance systems, outer space surveillance systems; meteorological precipitation monitoring; and guided missile target locating systems.

RADAR

3. Radar is a machine that uses radio waves to find other objects such as aircraft, ships, and rain.The basic parts of radar are:-

(a) The transmitter creates the radio waves.
(b) The antenna directs the radio waves.
(c) The receiver measures the waves which are bounced back by the object that the radar is trying to find.
(d) By doing this, the radar can find what place the object is at.

4. Radar is an object detection system which uses radio waves to determine the range, altitude, direction, or speed of objects. It can be used to detect aircraft, ships, spacecraft, guided missiles, motor vehicles, weather formations, and terrain. The radar dish or antenna transmits pulses of radio waves which bounce off any object in their path. The object returns a tiny part of the wave's energy to a dish or antenna which is usually located at the same site as the transmitter.

5. A radar system has a transmitter that emits radio waves called radar signals in predetermined directions. When these come into contact with an object they are usually reflected or scattered in many directions. Radar signals are reflected especially well by materials of considerable electrical conductivity—especially by most metals, by seawater and by wet lands. The radar signals that are reflected back towards the transmitter are the desirable ones that make radar work.

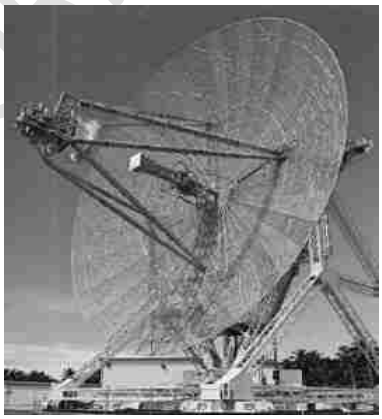
6. In aviation, aircraft are equipped with radar devices that warn of obstacles in or approaching their path and give accurate altitude readings.

TYPES OF RADARS

PRIMARY RADAR

7. This radar uses the principle of pulse technique to determine range and bearing of an object. Working on echo and search light principle, a transmitter transmits pulses. All objects in the path of the pulses will reflect and scatter this energy. Some of the reflected energy reaches the receiver. The reflected energy is processed to give the required information. In this radar, the object's cooperation is not required in the entire process.

SECONDARY RADAR



8. In this system, a transmitter transmits a group of pulses. An aerial in the path of the pulses receives the signals and passes it to receiver. If the pulses are identified, then the transmitter gives out a reply. In this radar active cooperation of the other object is also required.

CONTINUOUS WAVE RADAR

9. In this type of radar, both the transmission and the reception take place continuously. This requires set of two aerials, one for transmission and one for reception.

SUMMARY

10. Understanding the basic functions of Radar would help cadets in better assimilation of facilities available in the ATC and their role in promoting safe flying.

CHAPTER XVII- AEROMODELLING CAPSULE

HISTORY OF AEROMODELLING

1. Aeromodelling 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 aeromodelling 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 and problems of construction etc., very easy, apart from providing great personal satisfaction to the aero-modeler.

2. The history of aeromodelling 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 aeromodelling 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. In 1878, Professor Langley builds a petrol driven model called 'Aerodrome No.5'. This revolutionalised the concept of aeromodelling, as there was now an ideal power plant small enough for the requirement, available to the enthusiasts. Hundreds of varieties of petrol models were subsequently built. Later, these gave ways to more powerful diesel engines, which are in use even today.

MATERIALS USED IN AEROMODELLING

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

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

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

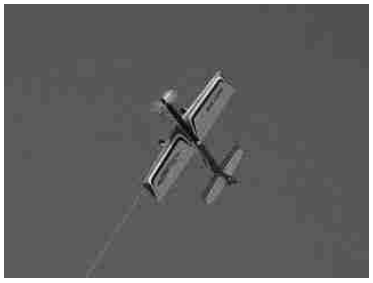
6. There are quite a number of variants of aeromodels, which are classified according to the role and utility of the particular type. These are static models, gliders, control line models and RC models.

TYPES OF AEROMODELLING

7. The following are the different type of Aeromodels:-

(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

SUMMARY

8. 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 XVIII- FLYING/BUILDING OF AEROMODELS

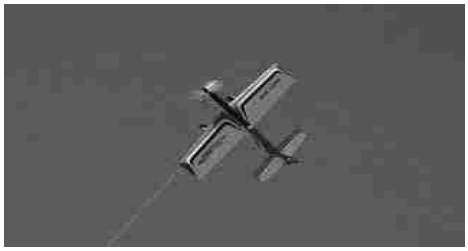
CONSTRUCTIONS OF STATIC MODELS

1. These are the miniature replicas of original aircrafts, full sized aircraft types and attract 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. Constructions 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 make sure it is proper as per the blue print. Parts are then assembledtogether 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



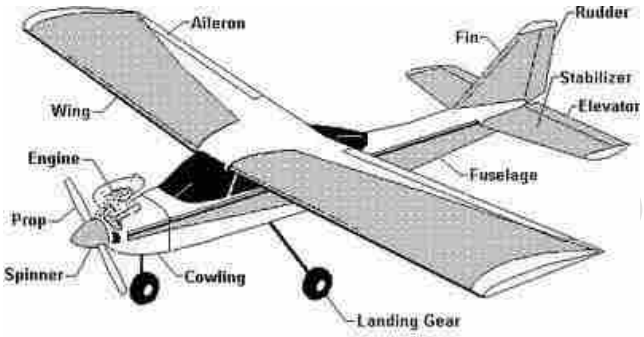
4. Each and every part of a model aero plane is important as it would not function in the absence of even one component. Construction plans are provided normally with all model kits. These should be studied thoroughly. Then follows the actual construction of various parts. The power units are, also available 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.

9. 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.

10. 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.

11. 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

12. 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.

13. 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.

14. 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. And the model launched gently the model should fly short distance and land perfectly.

GENERAL SAFETY CODE

15. 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 CONTROLSAFETY CODE

16. 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

17. 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 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 XIX- MICROLIGHT FLYING

1. Before Awarding C Certificate, Cadets have to be given a minimum Flying Experience of two sorties, duration 20 minutes each (Total of 40 minutes) in Second Year. In Third Year, Four Sorties of duration 20 minutes each (Total of 80 minutes), is to be given. A waiver can be given by ADG/DDG of the Dte in case of NO / Unserviceable Micro Light Aircraft or Runway under repair.

2. 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.

3. Parts of the Aircraft and some aspects of Aerodynamics are to be explained on the microlight itself.

CHAPTER XX- SIMULATOR FLYING

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