COMMAND AND STAFF TRAINING INSTITUTE

BANGLADESH AIR FORCE

Individual Staff Studies Programme (ISSP)

PROFESSIONAL SUBJECT-1 : ENGINEERING
PHASE-8 : PART-I

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PHASE-8 : PART-I

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Revised by : **Gp Capt Md Shafiqul Alam, psc, GD(N)**

Wg Cdr Md Ashraful Islam, Engg
Wg Cdr Sarker Ali Akbar, psc, Engg
Wg Cdr M Zahir Uddin, Engg

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INTRODUCTION TO THE PHASE

Scope of the Phase

1. Phase-8 Note (Part-I, ISS) is a self-contained précis. It contains part of the following subjects:

a. Technical Management.

b. Turboprop and Turboshaft Engine

c. Fuel System of Gas Turbine Engines

d. Hydraulic System

e. Pneumatic System

f. Basic Electronics

g. Computer Fundamental and Networking

h. Optical Fiber Communication and LOS Communication System of BAF.

j. Armament : Explosive Regulations & Administration.

k. Basic Types of Aircraft Ammunitions, Bombs, Rockets & Missiles.

l. Elementary Principles of Missile Guidance.

m. Gun Camera and AVTR

2. The syllabus has been so designed that you would be able to co-relate and implement (most cases) your knowledge in the profession field.

DUTIES & RESPONSIBILITIES OF DIRECTORATE AND ROLE & TASK OF MAINTENANCE UNIT IN BAF

RESPONSIBILITIES OF DIRECTORATE

Directorate of Engineering

1. Directorate of Engineering is responsible to ACAS (M) for the following:

   a. Formulation and implementation of policy for maintenance and overhaul of all aircraft, helicopter, aircraft engine special vehicle, aerospace ground equipment, life having equipment and air conditioners.

   b. Ensure technical investigation and inspection of aircraft, helicopter, MT Vehicle, aerospace ground equipment and spares.

   c. Implementation of technical planning in respect of aircraft operation and plan, Engineering.

   d. Promulgation of special Engineering task.

   e. Formulation of policy related to technical publication on and technical order.

   f. Determination of scale of MT vehicle, specialized vehicle air condition etc.

   g. Implementation of COAS orders/instructions related to Engineering range.

   h. Implementation of recommendation as per COAS inspection report related to Engineering Directorate.

Directorate of Projects

2. Director of Project is responsible to ACAS (M) for the following:

   a. Planning and induction of new weapon system a equipment in BAF.

   b. Dealing with training requirements relating to project in coordination with other concerned Directorates.

   c. Programming of foreign assistance team for BAF.

d. Liaison foreign countries on operations, training and maintenance matters related to on going projects.

e. Liaison with other Directorates and BAF Bases on progress of on going projects.

f. Determining and processing with Directorates of Operation and Works, the requirements in support of the new weapons and equipment eg, Airfield, Nav Aid, Hanger Workshop etc.

g. Obtaining Govt. sanction for procurement of new equipment and allocation of funds.

Directorate of Communication and Electronics

3. Director of Communication and Electronics is responsible to ACAS (M) for the following:

a. Formulation of Policy, Planning and Operational direction of Communication and Electronics Organization.

b. Formulation of Signals and Radar Maintenance Policy in respect of all ground and airborne electronic equipment.

c. Ensure procurement and serviceability of Communication, Avionics, Radar and Ground Electronics Equipment.

d. Assisting ACAS (M) in formulating BAF Communication security policy.

e. Maintaining liaison with other services and Government agencies in electronics fields.

f. D of C&E also act as an adviser to ACAS (O&T) in connection with operational signals matters life radio warfare, Nav Aids etc.

Directorate of Armament and Weapons

4. Director of Armament and Weapons is responsible to ACAS (M) for the following:

a. Formulation of Armament and Photo policies.

b. Security of technical faults and defects related to photo and armament range item and to recommend remedies.

c. Technical efficiency of all airborne and ground Armament, explosives and photo equipments.

d. Advising ACAS(M) on the technical capabilities and imitation of Armament equipments, explosives and photo equipments.

e. Initial investigation on Armament Accidents and recommending remedies.

f. Supervising technical Armament and Photo trails being under taken in BAF.

g. Sitting of all Air and ground ranges and advising air staff on all operational aspects associated with ranges.

h. Directing lower formations on improving methods of technical procedures.

j. Specifying the standard of technical training of Armament personnel.

k. Initial sitting of Explosive Arms and danger buildings.

l. Promulgation of red card, black list, yellow card and relegation instruction.

m. Keeping liaison with Army and Naval counter parts to evaluate the effectiveness of all newly introduced equipment in the services.

Director of Supply

5. Director of supply is responsible to ACAS (M) for the following:

a. Direction and control of provisioning of all ranges of equipment for BAF.

b. Direction and control of supply administration in BAF.

c. Control of printing and policy direction of BAF.

d. Preparation of supply plans and ensuring their execution/implementation.

e. Scrutiny of Supply establishment.

f. Liaison with procurement agencies regarding supplies.

g. Formulation of policy relating to movement of stores by surface transportation.

ROLE AND TASK OF MAINTENANCE UNIT IN BAF

201 MU, BAF

1. 201 MU, BAF is responsible for the following:

   a. Procurement and issue of all ranges of equipment used by BAF except medical, ration and explosive items.

   b. Provide logistic support to all Bases/Units.

   c. Repair of cat R/D items through respective maintenance unit or by out sourcing.

   d. Any other tasks given by Directorate of Supply.

203 MU, BAF

2. 203 MU, BAF is responsible for the following:

   a. Bulk storage and maintenance of ammunitions, explosives and missiles.

   b. Inspection of ammunitions and explosives and missiles.

   c. Ensure Issue and transportation of explosive items.

   d. To assist Air HQ for provisioning and procurement by submitting forecast.

   e. Any other task given by Air HQ.

205 MU, BAF

3. 205 MU, BAF is responsible for the following:

   a. Depot level repair of Communication, Radar, Avionics, Computer, Ground Electronics and Nav Aid equipment.

   b. Calibration of Precision Measuring Equipments (PME).

   c. Programming of RTs as per the frequency allotted by Air HQ (Dte C&E).

   d. Any other task given by Air HQ.

208 MU, BAF

4. 208 MU, BAF is responsible for the following:

a. Repair/overhaul of Bell series helicopter.

b. Carry out 1000/1200 hours inspection of Bell series helicopter.

c. Repair/overhaul of Bell series helicopter of sister services as per the directives of Air HQ.

d. Any other task given by Air HQ.

210 MU, BAF

5. 210 MU, BAF is responsible for the following:

a. 3rd line servicing and overhauling of PT-6 aircraft.

b. Structural repair of PT-6 aircraft.

c. To carry out overhauling of Critical components (rotables).

d. To carry out the special inspection of PT-6 aircraft.

e. To provide NDI and structural repair support to other aircraft of BAF.

f. To carry out overhauling of PT-6 aircraft of friendly Air Force.

212 MU, BAF

6. 212 MU, BAF is responsible for the following:

a. Storage and major repair/overhaul of all MT vehicles, generators, specialized vehicles and ground equipment.

b. Major repair/overhaul of air conditioners and refrigerators which are beyond repair capability of the bases.

c. Initial survey, discrepancy reporting and setting of newly procured MT vehicles,

d. Reconditioning of ground battery.

e. Repair of fuel pumps and injectors.

f. Repair of Motor and Generators.

g. Preparation of MT Vehicle/Specialized vehicle to deploy at UN mission.

TASK-1

TECHNICAL MANAGEMENT

TCTOs/TECHNICAL BULLETINS AND MODIFICATIONS

Objective

1. **Training.** At the end of the task you should be able to:

   a. Explain why TCTOs/Technical Bulletins are issued and how these are implemented.

   b. Explain how modifications are incorporated in the aircraft / equipment of the BAF and the procedure followed in this respect.

TCTOs/TECHNICAL BULLETINS AND MODIFICATIONS

TCTOs / Bulletins

1. Time compliance Technical Orders (TCTOS)/ Technical Bulletins are authorized directives to provide activities with instructions for accomplishing a one time change, modification, inspection of equipment or installation of new equipment. These are normally issued by the manufacturer to increase operational capability, correct a deficiency or improve safety of operation.

2. TCTOS/ Bulletins are first received by the Air Headquarters, where its applicability is studied. These are then forwarded to the Base, where the affect/equipment are located. At the Base, Quality Control is responsible to keep track of accomplishment of all TCTO's/Bulletins. After the TCTO's/Bulletins are studied and its capability determined these are then sent to the user activity, who in turn processes demand for kits, spares and special tools which may be needed to accomplish the TCTO's/Bulletins through material control.

3. Unless the TCTO's/Bulletins is of immediate / alert nature its impletions will be integrated with the schedule maintenance of affect aircraft / equipment. A monthly return is sent to Air HQ by all Bases showing the state of TCTO's/Bulletins received in the previous month and state of all TCTO's/Bulletins which have not yet been accomplished.

Modifications

4. BAF modifications procedure regarding airframe, aero engines and associated equipment is laid down in AFO 66-12. Modification can be of 2 types:

   a. Manufacturer's Modifications.

   b. Local Modification

5. **Manufacturer's Modifications.** On receipt of the modification instructions. Specialist Directorate will consider the advisability of introducing the modification in the BAF. If considered suitable it will be placed before the modification committee at Air HQs for consideration. After the modifications proposal has been accepted by the committee these are then sent to the concerned Bases/Units for implementation.

6. **Local Modification**. These are introduced to meet local requirements. These are sponsored by the concerned specialist directorate. Whenever the necessity for local modification is felt concerned base is asked to carry out a prototype modification for evaluation. After successful evaluation a draft modification leaflet is sent to Air HQ for approval and issue of engineering task for its implementation.

CANNIBALIZATION AND UNSATISFACTORY REPORTS

Objective

1. **Training.** At the end of this task you should be able to:

   a. Explain what is cannibalization and when is carried out.

   b. Explain the procedure followed in cannibalization.

   c. Explain when unsatisfactory Reports (SRs) on aircraft and equipment are raised and how these are processed.

UNSATISFACTORY REPORT (UR) :- AIRCRAFT AND EQUIPMENT

1. Defects or deficiencies of a mechanical, electrical or operational nature which are of sufficient significance to warrant further investigation or re-medical action are to be reported as 'Unsatisfactory Reports'. URs are rendered on the following occasions:

a. When instructed by Air HQ to do so.

b. When in the opinion of OC Maint Wing the defect warrant further remedial action/ investigation without waiting for Air HQ authority.

c. On all defect which are considered to have caused aircraft accidents (cross referred to aircraft accident investigation reports).

d. On all aero engines which became defective or are replaced before completion of this stipulated lives.

e. On all items failing during warranty period.

2. URs are submitted in AFTO Form 29. It is raised in conjunction with Quality Control and is raised in 6 copies, 4 copies sent to Air HQ and 1 copy sent to Maint Unit. The defective equipment is not to be dismantled or unnecessary disturbed before examination is over. The copy of UR meant for MU is to enclosed in the packing while sending the item to MU.

3. In case the items belonging to accident investigation, then it is to be marked with red letters 'UR investigation'. While dispatching Air HQ must be informed about dispatch. For items which have not involved in accident such as aero engines and power plant will not be dispatched unless authorized by Air HQ in case these are defective.

4. URs, can be categorized into following three categories:

a. **Category I - Emergency Action**. Apply where safety conditions are affected which can result in fatal or serious injuries to persons or extensive damage to valuable properties. This is reported by signal.

b. **Category II- Urgent Action.** Apply when potentially hazardous condition exist which could result in probable serious injury to persons or damage to valuable property or reduce the combat effectiveness of aircraft. This is also reported by signal.

c. **Category III-Routine Action.** Equipment or servicing deficiencies of substandard material, mechanical, operational or technical nature which could constitute a hazard through a prolonged continued use.

Cannibalization Policies

1. Cannibalization is the authorized removal of a specific' component (s) from one item of Air Force property for installation on another items of Air Force property to meet priority requirements, with the obligation of replacing the removed components.

2. Cannibalization will be resorted to only in unusual situations and as a last resort. OC Maint Wing or his authorized representative is responsible for control of Cannibalization.

3. Extreme caution will be exercised in the rouse of parts from wrecked or damaged equipment. Metal fittings, control surfaces, engine parts, accessories and" similar -sensitive parts may have been overstressed and may contain hidden failure. Before a reclaimed part from damaged or wrecked items is used, the part will be thoroughly inspected for its serviceability.

4. The parts cannibalized will be immediately requisitioned under appropriate priority in accordance with AFM 67-1

Cannibalization Request

Procedures

5. Before cannibalization is done Base Supply will make every effort to obtain the needed parts and furnish material control with the date when the item will be available through supply.

6. If the item is not, or will not be received in sufficient-time to prevent maintenance delay, then Material Control will verify that the needed part is not available at the base and ascertain the date it is likely to be available and finally decide whether cannibalization is warranted.

Cannibalization Procedures

7. When cannibalization is warranted, procedure will be followed:

a. Material Control will prepare AF Form 991 record of cannibalization, in triplicate and retain one copy. The other copies will be delivered to Maintenance Control to serve as notification that the parts will not meet the schedule deadline. Maintenance Control will determine the affect on maintenance schedules and unit mission.

b. Maintenance Control will also determine the item to be cannibalized and make necessary entries on the maintenance Control portion of AF Form - 991.

c. The AF Form 991 will be forwarded to OC Maint Wing or his authorized representative for review and approval.

d. After approval original copy of F - 991 will be held in suspense by work load and duplicate copy will be forwarded to the work center supervisor of the equipment from which the part is to be removed.

e. Completion of cannibalization will be reported to Maintenance Control by the requesting organization. Maint Control will indicate 'close-out' on F-991 and forward it to RR&A.

f. Material Control will take necessary requisition action to obtain the replacement items from supply with sufficient priority to meet the maintenance schedule.

MAINTENANCE OF AFTO FORM 781 SERIES AFTO FORMS 210, 212 AND SYMBOLS

Objective

1. **Training.** At the end of this phase you should be able to:

   a. Explain the purpose *of* AFTO Forms 781, 781A and 781 B.

   b. Explain the use *of* AFTO Forms 210, 211 and 212.

   c. Explain the various symbols used in AFTO Forms 781A, 781 B, 210, 211 and 212.

MAINTENANCE OF AFTO FORM 781 SERIES FOR AIRCRAFT MAINTENANCE DOCUMENTATION

1. **AFTO Form 781 - Aircraft Flight Report and Maintenance Record.** In this form flight date, (Particulars of crew members, flying time number of landings etc), maintenance and servicing performed on the aircraft are recorded. Pilot is responsible for recording the flight data and maintenance crews are responsible for recording the various maintenance and servicing performed on the aircraft. Crew chief is to ensure that sufficient F-781 are available in F-781 folder. At the end of the days flight these forms are sent to RR& A for the purpose of documentation and retention.

2. **AFTO Form 781A-Maintenance Discrepancy / Work Record.** This form has been designed so that each individual deficiency and discrepancy reported by Pilots or discovered by Maintenance Personnel can be documented for historical and filing purposes. Work performed to remove the defects / discrepancies are also recorded in the same form. Crew Chief is to ensure that recorded in the same form. Crew Chief is to ensure that sufficient copies of AFTO F-781A are available for the days' activity. He is also responsible for removing the Form 781A from the folder transcribing open entries to new F-781A and forwarding the removed forms to RR & A.

3. **AFTO Form 781 B-Aircraft Inspection Maintenance Status Record.** This form is used for recording certain semi permanent data such as aircraft Inspection status engine data, outstanding immediate alert bulletins, delayed discrepancies calendar inspection / item etc. Crew chief or the line chief will make the necessary entries in F-781 B with the exception of those entries specific to be accomplished by the maintenance officer. Whenever it is necessary to open a new F-781 B all un-cleared bulletins, delayed discrepancies and other data affecting the status of the aircraft will be carried forward to the new forms.

MAINTENANCE DOCUMENTATION: AFTO FORMS 210, 211 AND 212

1. AFTO Forms 210, 211 and 212 have been designed to service as the source documents for maintenance data collection system. This data collection system provides maintenance management with information as to what production jobs were performed.

2. **AFTO Form-210**. This is a Maintenance Discrepancy / Production credit Record (Single copy) form and is used to document the following:

a. On equipment work not involving removal and replacement of repairable items.

b. Look phase of inspection.

c. Servicing and support general actions.

3. **AFTO Form-211** This is Maintenance Discrepancy! Production Credit Record (four part) form and is used to document the following:

a. **AFTO F-221 Copy-1.** It will be used whenever removal and replacement of a repairable item is involved.

b. **AFTO F-211 Copy-2**. It will be used as a suspense copy for items requiring shop processing.

c. **AFTO F-211 Copy-3**. It will be used for all bench check credit and in-shop repair when done concurrently with bench check.

d. **AFTO F-211 Copy-4.** It will be used as a repairable part tag for off-base shipments. This form will also be used for repair actions which are performed separately form bench check.

4. **AFTO Form-212**. This form is Time Compliance technical order Work Record and will be used for recording all TCTO/Tech. Bulletin actions.

SYMBOLS

1. **Purpose and Use.** To conserve time and make important notation instantly apparent, certain symbols are used on the maintenance records to indicate the mechanical condition, fitness for flight, servicing, inspection and maintenance status of the equipment. It is important that these symbols and their use be fully understood in order that entries on the forms will be properly recorded.

2. **Where Entered.** Symbols will be entered in the following places:

a. In the 'SYM' col of Block A and the status today col of Block D of AFTO Form-781.

b. In 'SYM' Blocks of AFTO Form 781A.

c. In the 'SYM' col of AFTO Form 781B.

d. In the 'SYM' Block of AFTO Form-210, 211 and 212.

3. Following four types of symbols are used:

a. Red X.

b. Circled Red X

c. Red Dash.

d. Red Diagonal.

4. **Red** X. This symbol indicates that the aircraft or equipment is considered unsafe or unfit *for* flight until the unsatisfactory condition is remedied. On this basis no one will authorize or direct that the aircraft be flown until Red X is properly cleared. A red X will be entered in the appropriate locations under the following circumstances:

a. Immediately upon discovery of an unsatisfactory condition serious enough *to* warrant its use.

b. Upon receipt *of* an 'Immediate Action' technical bulletin.

c. Whenever maintenance is performed in or around areas of the air inlet section of an installed jet engine.

d. Whenever maintenance is performed on the flight control system.

e. Upon removal of any components, which effect safety of flight for which immediate replacement is not available?

f. Whenever egress system is partially or completely dismantled.

5. **Circled Red X**. A red X inside a circle is used to indicate that an aircraft is grounded pending compliance with an 'Urgent Action' technical bulletin. Once this Symbol is entered it will be treated the same as red-X for clearing action.

6. **Red Dash.** This symbol indicates that a required routine inspection. Scheduled necessary replacement or F.S.F. although due has not been completed. The presence of this symbol indicates that the conditions of the equipment is unknown and may be an errowous symbol in that a red-X condition may exist. This condition will be corrected as soon as possible by performing the required inspection, accessory replacement, F.C.F and any necessary maintenance.

7. **Red Diagonal.** This symbol indicates that an unsatisfactory condition exist which may affect the flying safety or the flying efficiency of the aircraft but is not sufficiently urgent or dangerous to warrant grounding of the aircraft. This symbol when .entered in F-781, F-781A, or F-781 B will require exceptional release before flight.

TASK-2

TURBOPROP AND TURBOSHAFT ENGINE

Introduction

1. The turboprop engine consists of a gas turbine engine driving a propeller. In the turbojet engine the turbine extracts only sufficient energy from the gas flow to drive the compressor and engine accessories, leaving the remaining energy to provide the high velocity propulsive jet. By comparison, the turbine stages of the turboprop engine absorb the majority of the gas energy because of the additional power required to drive the propeller, leaving only a small, residual jet thrust at the propelling nozzle.

2. Turbo-shaft engines work on identical principles , except that all the useful gas energy is absorbed by the turbine to produce rotary shaft power and the residual thrust is negligible. Such engines find particular applications in helicopters and hovercraft. The lack of a significant propulsive jet mean that these engines can be mounted in any position in the airframe and this flexibility is increased by the very compact design and layout of modern turbo-shaft engine.

3. Because the propeller wastes less kinetic energy in its slipstream than a turbojet in its exhaust, the turboprop is the most efficient method of using the gas turbine cycle at low and medium and at speeds up to approximately 35kt. At higher speeds and altitudes the efficiency of the propeller deteriorates rapidly because of the development of shock waves on the blade tips.

Types of Turboprop Engines

4. Current turboprop engines can be categorized according to the method used to achieve propeller drive; these categories are:

a. Coupled Power Turbine.

b. Free Power Turbine.

c. Compound Engine.

5. **Coupled Power Turbine.** The coupled power turbine engine is the simplest adaptation from the turbojet engine,. In this configuration, the gas flow is fully expanded across a turbine which drives the compressor; the surplus power developed being transmitted to the propeller by a common drive shaft via suitable reduction gearing. This arrangement is shown diagrammatically in Fig. The Astazon XVI and Rolls-Royce Dart series engines are typical of the coupled power turbine engine.

6. **Free Power Turbine**. In this arrangement a gas turbine acts & simply as a gas generator to supply high energy gases to an independent free power turbine. The gases are expended across the free turbine which is connected to the propeller drive shaft via reduction gearing. The layout of a free power turbine engine is shown in Fig. The Rolls-Royce Proteus-engine is typical of this type. The free turbine arrangement is very flexible; it is easy to start due to the absence of propeller drag, and the propeller and gas generator shafts can assume their optimum speeds independently.

7. **Compounded Engine.** The compound engine arrangement feature a two-spool engine, with the propeller drive correctly connected to the low pressure spool. The Rolls Royce Tyne engine is typical of the compounded engine arrangement.

Types of Turbo-shaft Engines

8. Turbo-shaft engines are invariably of the free power turbine arrangement. The free turbine can be regarded as a fluid coupling and this is particularly useful for helicopter applications were the requirement for a mechanical clutch in the transmission for stray-up and autorotation is eliminated. The general arrangement of turbo-shaft engine is showing in Fig.

Reduction Gearing

9. The power turbine shaft of a turboprop engine normally rotates at around 8.000 to 10.000 rpm, although rpm of over 40.000 are found in some engines of small diameter. However the rotational sped of the propeller is dictated by the limited tip velocity. A large reduction of shaft speed must be provided in order to match the power turbine to the propeller. The reduction gearing must provide a propeller shaft speed which can be utilized effectively by the propeller; gearing rates of between 6 and 20;1 are typical. In the direct coupled power turbine and compounded engines, the shaft baring the compressor and turbine assemblies drives the propeller directly through a reduction gear box. In the free turbine arrangement reduction gearing on the turbine shaft is still necessary, this is because the turbine operates at high speed for maximum efficiency. The reduction gearing accounts for a large proportion (up to 25%) of the total weigh of a turboprop engine and also increases its complexity, power losses of the order of 3 to 4% are incurred in the gearing (eg on a turboprop producing 6,000 eshp, some 200 eshp is lost Through the gearing).

Turboprop Performance

10. The propeller has a higher propulsive efficiency than the turbojet up to speed of approximately 500 kt, and higher than a turbofan engine up to approximately 450 kt. Compared with a piston engine of equivalent power, the turboprop has a higher power weight ratio, and a greater fatigue life because of the reduced vibration level from the gas turbine rotation assemblies.

11. **Turboprop and Turbo-shaft Ratings**. The following terms are used to describe turboprop and turbo-shaft rating.

a. **Shaft Hersepower(shp).** Shaft horsepower is define as the power available from an engine at the propeller drive shaft of the engine.

b. **Equivalent shaft Horsepower (eshp).** Although most of the energy available afford driving the compressor is taken out by the turbine in the form of shaft horsepower here is still some residual thrust. The sum of shp and jet horsepower known as equivalent shaft horsepower and indicates the total pore available from the engine. For static conditions, 1hp can be considered to be the equivalent of 2.5 1bf of thrust, Thus, eshp=sho+Thrust.

c. **Kilowatts (kw).** It is becoming usual for turbo shaft power to be measured in kilowatts (compare KN for thrust). There is no SI term equivalent to eshp; for comparison. 746W=1hp may be used.

TASK- 3

FUEL SYSTEM OF GAS TURBINE ENGINES

Requirement of a fuel system

1. The primary requirements of a Gas turbine fuel systems are following:

   a. One pilot must always have complete control over the engine at all times.

   b. Fuel must be fed into combustion chambers in a condition that will ensure good combustion.

   c. Control turbine and compressor speed.

   d. Delivery of fuel must be corrected for changes in ambient temperature and pressure due to altitude or change in aircraft speed.

   e. Starting conditions should be good for ground start and air start.

   f. Rapid increase must be obtainable for emergencies, such as blocked landing.

   g. Over-riding controls must be provided to prevent engine damage by over temperature or over speed.

Fuel requirements

2. The quantity of fuel supplied to an engine depends upon engine RPM inlet air temperature and pressure, JPT and other inter-related quantities. In general, engine RPM are selected by the pilot and fuel system automatically adjusts itself to meet the changing requirements.

3. The fuel requirement between 20 to 80% rpm rises slowly with increase in speed, but beyond the point the fuel requirement rises sharply with increase in rpm Fig. 1 shows a variation in fuel requirement with rpm at sea level under static condition.

4. The fuel requirement depends upon the pressure at the air intake. This pressure depends upon two factors ambient temperature and aircraft speed. Higher the ambient temperature lower is the pressure at air intake and hence the mass of air flow is lss, so fuel requirement is less and vice verses. With increase in aircraft speed, ram effect increases and hence mass of air flow increases. There is corresponding increase in fuel requirement.

5. With increase in altitude, density and temperature of air falls. These two factors have opposite effect on air mass flow and hence fuel requirements. But overall effect is decreases in air mass now and hence fuel required decreased. Due to decrease in density engine has a light tendency to speed up; this tendency is curbed by supplying slightly less fuel to the engine.

6. In practice the fuel supplied to the engine is always in excess of that theoretically required by an amount depending upon combustion efficiency. At sea level it is between 95% to 98% but it falls at lower rpm and also with altitude. So there is corresponding increase in the value of fuel required as compared to the critical requirement.

Basic fuel systems

7. Fuel systems can be broadly divided into open-loop or close-loop systems. In open-loop system, the pilot has control over the quantity of fuel through throttle valve. The fuel for required rpm is selected by the pilot. Any change in fuel requirement by change in conditions of temperature and pressure is effected automatically by the system to keep selected rpm. Where as, in close-loop system, pilot has no direct control over

fuel. There is an engine speed fuel-metering control which compares signal from speed measuring device with the speed selected (of course by pilot) and automatically monitors the fuel flow to maintain required speed under those conditions of temperature and pressure.

Open Loop System

8. One of very popular design is hydro mechanical open-loop system, in which either fuel pressure or fuel flow is varied to suit engine demand at particular rpm ad pressure and temperature at intake. These systems have pressure operated derv mechanism either t adjust pump out put directly or to operate valves which restrict or spill back some of fuel being supplied by the pump.

Pressure Control System

9. A typical pressure control open-loop system is shown in Fig-2. The fuel is delivered at pressure of rank pump through a low pressure (LP) filter to a constant delivery pump. This pump is divan by engine at a suitable speed through gears the pjm output is fed to a control valve, through a high pressure filter. The control valve meters the fuel hydro mechanically depending upon the little position ie rpm requirement by the pilot and nacelle pressure and by passes the excessive fuel to the pump inlet or fuel tank. Thus fuel delivery pressure is reduced.

10. By operating throttle lever pilot conveys his rpm requirements, control valve maintains the same rpm under changing conditions of attitude temperature and aircraft speed changing the by pass fuel.

11. The metered fuel from control valve is served to fuel flow divider, through high pressure cock HP cock is to stop fuel in emergency. Fuel flow divider, at low fuel pressure, service fuel to small orifice in the burner and at pressures higher than preset valve; it allows the fuel to pass through bigger orifice. This ensures better atomization and better starting conditions.

12. Constant delivery pump in this system can be replaced by a variable displacement pump. In this pump pressure is varied varying the piston strokes length in the cylinders. The variant of stroke length (Displacement) is controlled a barometric pressure control (BPC) nit. This is a servomechanbrism and is governed by naccole pressure and thus gives correction for aircraft speed, altitude, and ambient temperature. In such case control valve becomes only throttle valve and speed governor.

13. In older fuel system fuel control valve or fuel regulator was not used as one unit. Each of its functions was performed by an independent unit. Pressure sensing was achieved by a separate barometer pressure unit operating on principle of aneroid barometer. RFM control was achieved by a speed governor. Throttle valve was a separate unit.

Flow Control System

14. This system makes use of a variable displacement fuel pump. The metering is done by varying pressure across a variable orifice. The fuel control valve in pressure control system is replaced by units which embodies a number of separate but inter related items. These items are throttle valve, high pressure cock and fuel control mechanism. This unit is known as full range flow control unit.

15. Full range flow control unit is a compact assembly eliminating unnecessary pipes. The variable metering orifice in this unit is controlled by throttle. The size of the orifice is altitudes and ambient temperatures. The pressure difference across the orifice is maintained by changing the output pressure of the pump.

TASK - 4

HYDRAULIC SYSTEM

Introduction

1. The fol wing definitions should be understood before reading further:

   a. **Intensity of Pressure.** Intensity of pressure is the force per unit area exerted by a fluid on the surface of a container. It is generally measured in pounds per square inch. Throughout this chapter the term pressure is used to indicate intensity of pressure expressed as pounds per square inch (psi).

   b. **Total Effective Pressure.** This the total force exerted on a particular surface of a container. It is calculated from the following formula.

   c. **A Fluid.** All liquids and gases which change shape to suit the shape of the vessel which contains them are fluids.

Operation Principles

2. Hydraulic systems afford convenient means for transmitting power for the operation of such services as retractable undercarriages, flaps, bomb doors, wheel brakes, etc, ie those services that require considerable power for short periods at infrequent intervals. Hydraulic systems are also used extensively in supplying the effort required to move the control surfaces in power-operated and power-assisted control system.

3. The hydraulic pumps used to generate the necessary pressure and pipeline systems which transmit this pressure to remote points in the airframe, which less than purely mechanical or electrical system designed for the same purpose.

4. In hydraulic and pneumatic systems, power is transmitted as fluid pressure to the mechanism which converts this power into mechanical work. If fluid is confined under pressure in a container, the pressure is same on all surfaces of the container Fig 1 shows a cylinder with a piston and a piston-ord. If the fluid in the cylinder is at a pressure (p) of, say, 1 psi and the area (A) of the face of the piston is 10 sq in the total force acting on th piston and transmitted by the rod to any mechanism to which it may be connected is x A= 10 x 10= 100 psi.

5. Fig 2 and 3 illustrate the application of the principle of fluid pressure in a simple hydraulic machine. In Fig 2 two cylinders are shown coupled by a pipe fitted with a pressure gauge. The small cylinder is fitted with a piston of 10 sqn in area (A1), the large cylinder has a piston of f100 sqn in (A2). Application of a force (F1) dof 100 1b to the rod of th small piston produces throughout the fluid a pressure (P) of $\frac{F1}{100}$=10 psi as indicated by th pressure gauge. This pressure acting on the A1 10 face of the large piston produces a face of P x A2 = 10 x 100 =1,000 1b, this supporting the force on the second cylinder (F2).

6. In a hydraulic machine, the cylinder and pipes are filled with a liquid (usually oil) which for all practical purposes may be considered as being incompressible. It follows that if the small piston is pushed downwards in the cylinder through a distance of five inches, as shown in Fig 3, the large piston will move upwards in its cylinder through a distance inversely proportional to the areas of the two pistons, ie, through.

$\frac{10 \times 5}{100}$ = ½ inches

thus raising the large piston on wl-ich is exited a force of 1,000 1b through this distance. The work done by the small force i,e force x distance through which its point of application moves) is transmitted hydraulically and equals the work expended in moving the greater force through smaller distance. This illustrates the principle of any hydraulic power transmission.

7. Owing to the incompressibility of liquids, hydraulic system are just as positive in operation as mechanical power generator is connected through piston rods, gearing, ,or similar links to the load. The speeds of operation of the services are controlled by pipe sizes and restrictions fitted in the pipelines.

8. Most sector valves in aircraft hydraulic systems ar fitted near the jacks, whom they control, thus reducing the length of pipelines. In such cases the valves maybe operated directly by a mechanical linkage, or electrically by solenoids, or small electric motor units, energized from the aircraft electrical system by the operation of switches.

Types of System

9. There are two types of hydraulic system:

a. **Constant Delivery Type**. In this type the pump delivering fluid whether or not a service is being operated. Cutout valves and on accumulator are used.

b. **Constant Pressure Type Live-Line System**. In this application the pump incorporates a pressure-operated mechanism which causes the amount of fluid delivered by the pump to reduce when the system pressure approaches a set figure, until eventually the delivery ceases altogether, the pressure being stored in the line. When a service is selected and the system pressure fails the pump again starts to deliver fluid until the pressure is restored. No accumulated is necessary in this system, which is generally known as the life-line system.

Description of Components

10. **Hydraulic Pump**. This unit generates the hydraulic pressure and delivers it to the pressure lines in the system. It is usually either engine-driven or electrically-powered. If the pump id driven via the engine gear box it will be running continuously, whereas some electrically-op rated pumps incorporate a pressure-operated switch which ensures that

the pump is running only when the pressure in the system falls below a predetermined level. The mechanical details of the pumps very considerably from type to type.

11. **Cut-Out Valves**. When a selected service has completed its operation the pressure I the line from the pump rises until the relief valve opens. This valve, which is frequently incorporated in the pump and usually an automatic by-pass valve known as a cut-out, diver in the fluid from the pump to the reservoir at low pressure, while lacking the fluid to the jacks at high pressure.

12. **Accumulator.** An accumulator consists of a steel cylinder closed at one end and connected to the pressure line at the other, and a floating piston. This piston separates hydraulic fluid at one end of the cylinder from compressed air at the other. The accumulator is initially charged with air at about half the normal operating pressure of the system, and hydraulic fluid from the pump will force the piston towards the compressed air and the cylinder, further compressing the air. The compressed air acts as a spring, and even though there may be internal locks in the jacks and valves the accumulator will compensate for the until the oil level falls to such on extent that the air expand and its compensate for the until the oil level falls to such on extent that the air expand and its pressure drops to what it termed “cut-in pressure”. The pump by-pass valve then closes automatically and the pump replenishes the accumulator with fluid. The accumulator also serves the functions of providing a limited reserve of fluid under pressure should the pump fail, and reducing hydraulic shocks throughout the system.

13. **Hand Pump.** This is installed as an emergency pwer source when the engine-driven pump of engine fails or when a leck occur in the pipeline system. In these cases a reserve of fluid is ensured by connecting the engine-driven pump to a stack pipe in the reservoir and taking a hand pump supply from bottom of the reservoir.

14. **Selector Valve.** Each service has its own selector valve although more than one jack within the service may be operated by the selector valve, eg two undercarriage jacks may operate from a single selector valve.

15. **Brake Relay Valve.** Hydraulically-operated wheel brakes may be controlled either by a lever or the control column, differential control being obtained by a relay valve interconnected with the rudder bar, or by twin toe-operated pedals, each moving a small piston in a cylinder and so controlling the relay valve hydraulically. From the hydraulic supply circuit, fluid passes through a non-return valve to the brake relay control valve. For emergency operation of the brakes in the event of hydraulic failure, a hydraulic accumulator is fitted between the non-return valve and the brake relay control valve. From the relay control valve two pipes convey fluid to the wheel brakes. From those two pipes, branch pipes read to two pressure relays which are connected to a triple-pressure gauge in the cockpit. A third connection on the gauge shows the working pressure in the system.

16. **Thermal Relief Valve.** Those valves are designed to release excessive pressure caused by the increase in temperature of fluid in the hydraulic system of an aircraft. The fluid is normally trapped between non-return valves and selector valves or jacks, etc and because it may be considered as being incompressible, the temperature increase could cause on unacceptable pressure build-up in the pipe lines.

Emergency Operation of the services.

17. In some Win-engine aircraft a pump is mounted on each engine thus reducing the risk of failure the system due to pump or engine failure. The hand pump is frequently used as an alternative source, but its operation the services, particularly the under carriage, is usually slow. Owing to the limitations of the hand pump, additional means of lowering the undercarriage and flaps are usually provided. This generally consists of either a separate accumulator or a compressed air bottle, connected via on emergency control valve through independent pillions to the down side of the undercarriage. On some aircraft, fitted with hydraulically-powered controls, two or even three separate systems and used. Thus, in the event of failure of the main system, there is always a standby available for use.

TASK - 5

PNEUMATIC SYSTEM

Introduction

1. Pneumatic system have for may velars been used to operate undercarriages, etc. However, ,they are now generally used to operate these services which require less power, such as radiator and oil cooler shutter, supercharger gear-changing mechanisms, Wheel brakes, hood and door seals, and windscreen wipers, Modern applications include air turbine started units for gas turbine engine and for constant speed alternators

Basic Generating Systems.

2. The basic generating system consists of the following components:

a. **Compressor**. Normally a single-cyclynder air cooled compressor driven by the eng or gear box of the aircraft.

b. **Ruffled Valve.** This is normally mounted close to the compressor and warmed by air as a safeguard against low temperature conditions causing freezing of the other valves is the system.

c. **Ground Charging Valve** . This permits the storage cylinder to be charged from ground supply sources when the aircraft compressor is not running.

d. **Anti-Freezer.** This may be fitted in certain aircraft . It consists of methanol in controller . The methanol is vaporized by the warm air from the compressor and circulated through the rest of the system. Lowering the freezing point of any measure and permitting satisfactory operation in very low temperature.

e. **Oil and Water Trap**. Moisture, which is always present in the atmospheres, is precipitated in the oil and water trap which is mounted at the lowest point in the generating system. A drain valve is fitted at the bottom of the oil and water trap so that the collected fluid may be drained away.

f. **Pressure Regulation Valve**. As the compressor is generating air pressure all the time the engine is running, when the storage cylinder is fully charged lthe regulating valve will by-pass the compressor output the atmosphere. A pressure sensitive bellows-loaded safety valve is fitted. When the engine is stopped, thy prevented from leaking back into the compressor by a non-return valve on the outlets side of the regulating valve.

g. **Storage Cylinder (s).** The cylinder(s) act as a reservoir to store compressed air, giving a reserve of power for short bursts of heavy service operation, or emergency use in the event of engine or compressor failure

TASK – 6
C & E

BASIC ELECTRONICS

Introduction

1. Electronics means study of electrons at work. In early days of Electronic, vacuum tubes were used to put electrons at work. But soon the vacuum tubes were replaced by semiconductor diodes and transistors which had no heater and needed no vacuum. And yet they performed the same functions as the vacuum tubes more efficiently and more economically. With the advent of transistors a new era emerged the era of semiconductors.

2. This section briefly deals with the study of semiconductor devices.

Semiconductor Mode and Diagram

3. Transistors are made of semiconductor materials such as silicon and germanium. These are materials whose resistance is somewhere between that of conductor and insulator. The resistance of either silicon or germanium is, therefore, more than the resistance of a good conductor and less than an insulator.

4. Figure-1 indicates that an atom of silicon has 14 orbital electrons. These electrons are located in three shells. There are 2 electrons in the entire inner of first shell. There are 8 electrons in the second shell and 4 electrons in the outer or valence shell.

5. The individual atoms combine to from a solid crystal share their outer shell of valence electron with adjacent atoms. only there valance electrons are shared .therefore, only the four electrons from the valence shell of each atom need to be considered. A simplified atom showing only the outer shell is shown in Fig-2. Note that the simplified atom of germanium looks like a simplified atom of silicon. Such being the case the covalent diagram Fig-2 shows only these four valence electrons. Since every valence electron is shared and bound by more that one electron atom. A crystal formed by millions of these atoms will result in a bar of semiconductor material that has very few free electrons. If there were no free electrons in the material, it would be a perfect insulator. Such is the case at temperature of absolute zero.

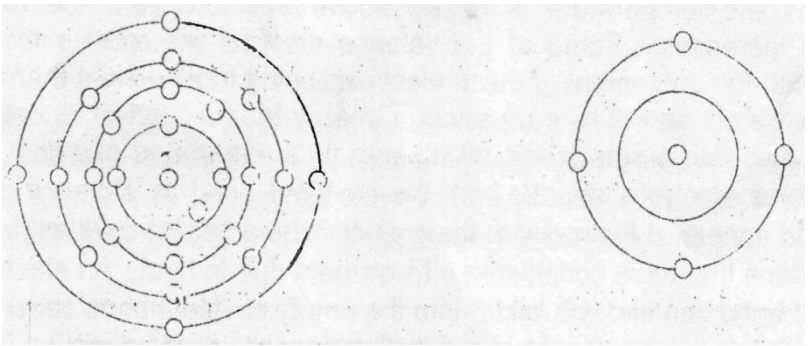


Fig- 1 Fig- 2

Production of Positive (Holes) and Negative (Free Electrons) Charge Carriers in Pure Semiconductor Materials

6. The atoms of an element will combine in a grouping such that eight valence electrons are shared in the chemical combination. For example, water is made up of two atoms of hydrogen and one atom of oxygen. A hydrogen atom has one electron in its outermost shell and oxygen atom has six electrons in its outer shell. The combination of the two hydrogen atoms with the one oxygen atom results in eight electrons being shared in the chemical combination called water.

7. Consider the covalent bonding diagram of silicon or germanium. Since the outer shell have four electrons each, the eight electron grouping uses every valence electron in covalent bonds are evenly possible covalent bond has an electron in it if perfectly pure crystal has been formed. Fig-3 shows the covalent bonding of pure silicon or germanium at the same time showing the mobi8le positive and negative charge associated with broken covalent and at room temperature.

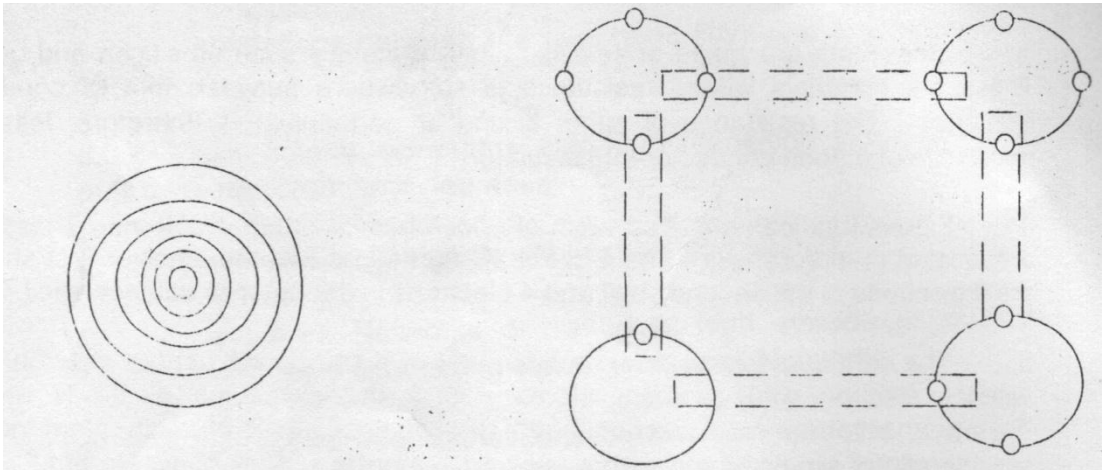


Fig-3 Pure silicon or Germanium at Room Temperature.

8. At temperature of absolute zero, no electron has energy to be bound. Therefore, in order to have a perfect crystal, the material must be pure and its temperature must be absolute zero. If these two conditions are satisfied. There would be no mobile charge carriers in the crystal and it would be a perfect insulator.

9. As the temperature is raised above absolute zero the movement of valence electron increases. Some of the valence electron will receive more heat en energy than others with the movement of these electrons being more violent than others. Occasionally, a valence electron will take on enough energy to "pop" out of its covalent bond. When it does, it flies into empty space taking with its associated negative charge. As soon as the valence electrons depart, from the covalent bond its absence causes a net positive charge to appear at that point in the crystal. The adjacent covalent bond are still occupied by electrons that have considerable Movement due to heat. An electron from one of these covalent bond can and will "slide" into the empty covalent bond causing it to be filled. That is, the positive charge moves in a direction opposite to the direction from which the broken covalent bond is filled. This action is continuously repeated from random directions, the results being that the positive charge migrate through the valence bond to many random points in the crystal. This movil (+) Charge is called a "Hole". Bear in mind that a hole has to be both a positive charge and be mobile.

10. The number of holes and free electrons produced in a crystal will depend primarily upon two factors. First how lightly the valence electrons are bound in the lattice network secondary the temperature of the material. Since a silicon atom has one less shell than a germanium atom the valence electron of silicon atoms. The valence electron of silicon atoms has less energy than the valence electron of germanium atoms. Since the silicon valence electron have less energy then germanium atoms, more energy is required in silicon than in germanium to "pot" an electron out of a covalent bond. Therefore, at a certain room temperature silicon will have a fewer free electron and holes. It is a poor conductor than germanium at room-temperature because it has fewer mobile charge carrier available for conduction.

Formation of the PN Junction

11. A junction diode is simply a bar of a either silicon on germanium employing P doping in one section and N doping in the other section. This bar is one bar of semiconductor material doped differentially in two sections. It is not two separate pieces of material. For example, certain impurities are added to pure silicon to form P-type and impurities are added to form N-type. The resulting N-type material is one which has an excess of electrons. In other words, the majority current carriers are electrons. In the P-type materials, the majority current carrier are holes. A hole is the absence of an electron in the atomic structure of P-type silicon material, and nit acts like a positive charge. P-type semiconductor material has an excess of holes to holes to support a current flow.

ANODE CATHODE CATHODE

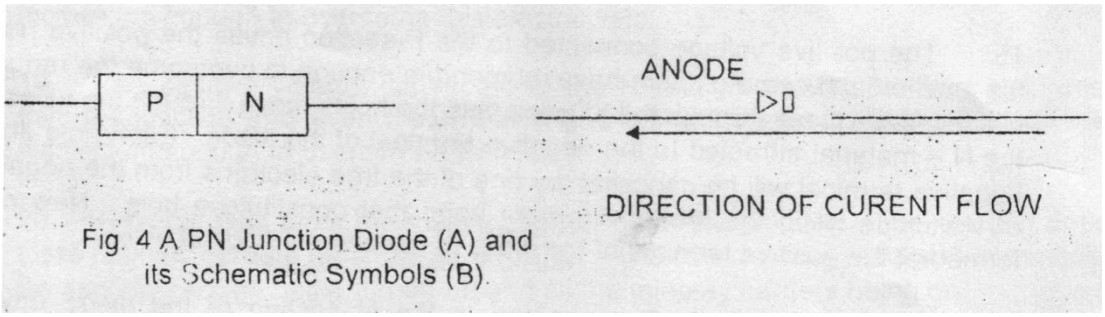


Fig. 4 A PN Junction Diode (A) and its Schematic Symbols (B).

12. Transistors and other semiconductor devices such as diodes and integrated circuits are made by combining P-type and N-type materials. For example, a diode is formed by joining P-types and N-types sections as shown in Fig-4. The P-section is designated as the anode or plate and the N-section is designated as the cathode.

The Forward Biased PN Junction

13. A voltage impressed across the ends of a PN junction diode is called "dicod bias". If the diode bias cancels out part of the depletion region the diode is said to be "forward bias".

If the diod bias voltage **adds** to the depletion region field the diode is said to be "reverse bias".

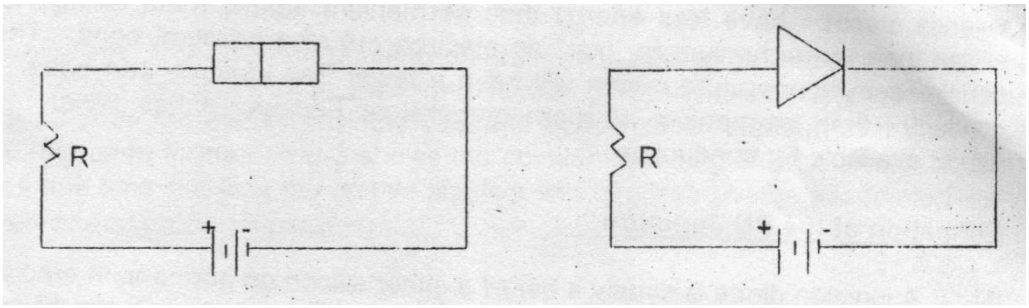


Fig-5 Forward biasing a PN Junction diode so that it conducts.

14. Fig-5 shows a circuit that is forward biased. The positive terminal of the battery must be connected to the P-doped section of the diode and the negative terminal of the battery must be connected to the N-doped section of the diode in order to forward bias that diode. A voltage drop of approximately 0.7 volts occur across a silicon diode. The drop is constant regardless of the current value. The drop across a conducting germanium diode is about 0.30 volts.

15. The positive voltage connected to the P-section drives the positive holes toward the junction and some of them have momentum enough to overcome the reduced junction electric field. Once through the junction field the holes move through the valence bonds on the N-material attracted to the negative terminal of the diode. Each hole arriving at this negative terminal will be cancelled by one of the free electrons from the negative terminal of the diode filling the broken covalent bond that constitute a hole. New holes will be formed at the positive terminal of the diode to replace the original holes.

16. The negative voltage connected to the N-section of the diode drives the free electrons towards the junction and some of them have momentum enough to overcome the reduced junction field. Once through the junction field the free electrons move through the empty space of the P-section attracted to the positive terminal of the diode and .... into the wire of the external circuit by the positive battery voltage.

The Reverse Bias PN Junction

17. To reverse bias a PN junction, the negative terminal of battery must be connected to the P-section of the diode and the diode Fig-6 shows a reverse diode.

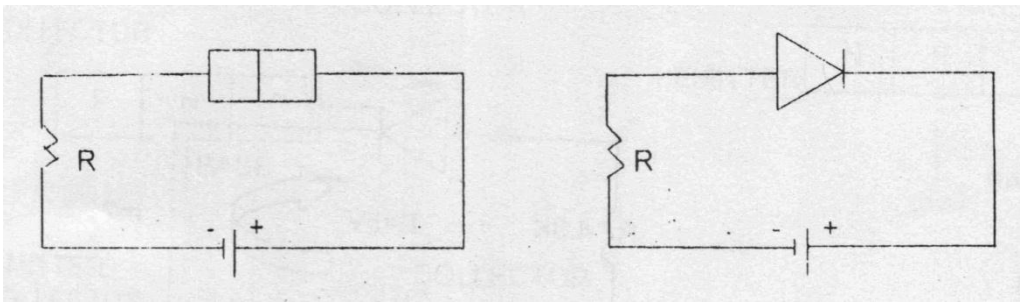


Fig-6 A Reverse Bias PN Junction Diode.

18. The negative voltage connected to the P-section attracts the holes away from the junction and even those that might be close to the increased electric field do not have momentum enough to overcome this electric field.

19. The positive voltage connected to the N-section attracts the free electrons away from the junction and even those that might to the increased electric field do not have momentum enough to overcome this field.

20. Reverse bias turns the majority carrier off at the junction. The junction appears to these majority carriers as an **open circuits**. The reverse bias results in essentially all of the majority carriers being turned off and all the majority carriers being on.

Comparison of Forward and Reverse Bias

21. When a diode is forward biased, great amount of majority current carriers flows for a small amount of bias voltage constituting large diode current. However, there are very few majority carriers and when the diode is reverse biased a small amount of current flows. The ratio of the forward current is called "front -to-back ratio". A front -to-back ratio of 1000:1 is not un common. The resistance of a forward biased diode is considered very low, in order of a few ohms. The resistance of a reverse biased diode is very high.

Sample Problem

22. Figure below shows a silicon diode that is forward bias. How much current flows in the circuit ?

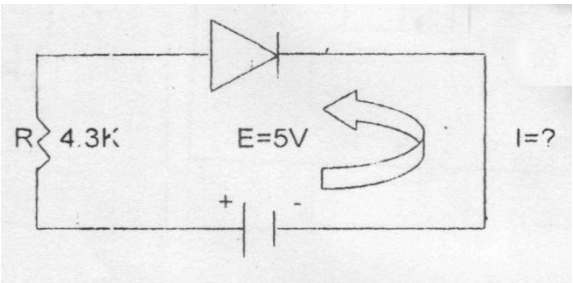


Fig-7 Forward Bias Silicon Diode

Solution

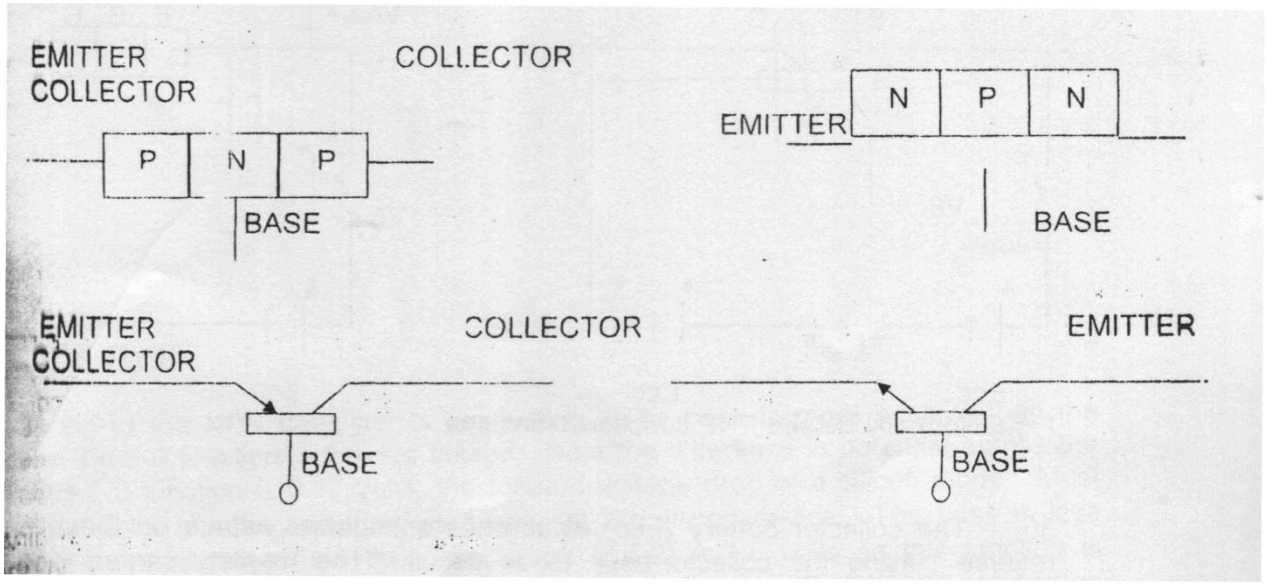
23. In this circuit the diode is forward biased because the polarity of the applied voltage is correct. Therefore, the current does flow. This current is limited by the resistance, but of course, is also a function of the battery voltage and the diode voltage drop. In this circuit, the diode drop is about n0.7 volts because the device is silicon. This means that the voltage drop across the resistor is (5-0.7) = 4.3 volts. The current I is then found by Ohms' law.

$$I = \frac{E}{R} = \frac{4.3}{4300} = 0.0001 \text{ Amp} \quad 1 \text{ ma}$$

Transistors

24. Transistors are simply an extension of the junction diode concept. Transistors are formed by combining the P-and N-Type material to from two junctions. This is done with three semiconductor elements.

25. Fig-7 illustrates the two possible combinations. The first set of drawing shows a transistor with two P-doped sections and one N-doped section. The next of drawing shows a transistor with two N-doped and one P-doped section. The transistor with the two P-doped section is called, "PNP" type transistor. The transistor with two N-doped sections is called an "NPN" transistor.



26. In both types the materials, "sandwiched" in the middle is called the **base**. The schematic symbol of the base is shown as a bar with an extended lead. One of the end sections in both types is called the "collector" The other end section is called the "emitter". The emitter section is drawn in the form of an arrow in the schematic representation

27. The arrow identifying the emitter lead of the schematic also indicates the types of transistor **The arrow pointing the base of the transistor in PNP. The arrow pointing away from the base of the transistor in NPN**.

Normal Transistor bias

28. A PNP transistor biased for operation as an amplifier is shown in Fig-8. Notice that the battery (Ecc) connected between the emitter and base forward biases the emitter to base PN junction. The battery connected between collector and base (Ecc) reverse biases the emitter -to-base circuit and a reverse biased collector base junction "Normal amplifier bias" is a forward biased emitter -base circuit and a reverse biased collector -base junction.

29. An NPN junction transistor biased for operation as as amplifier is shown in Fig-9. Notice that the (Ecc) battery are inserted in the circuit such that the negative terminal of the Ecc battery is connected to the N emitter material and the positive terminal of the Ecc battery is connected to the N collector material . The emitter-to-junction is reversed

biased. Both the PNP junction transistor requires a forward biased emitter-to-base junction and a reverse biased collector-to-base junction for normal operation as an amplifier.

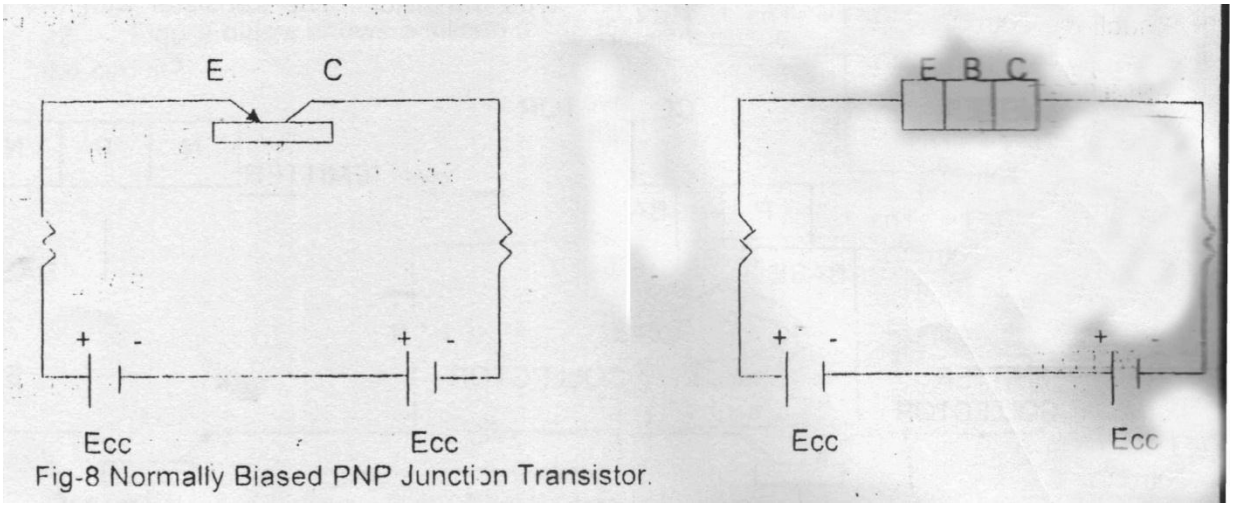


Fig-8 Normally Biased PNP Junction Transistor.

30. The collector battery (Ecc) establishes a negative voltage on the base terminal reverse biasing the collector-base diode circuit. The majority carriers (hblos in the collector and free elector in the base) are **turned** of at the collector-bas junction.

31. The emitter battery/(Ecc) establishes a positive voltage on the emitter terminal and a negative voltage on the base terminal forward biasing the emitter-base diode circuit. The majority carriers (holes in the emitter and free electrons in the base) are turned on at the emitter-base junction.

32. A hole under the influence of an-electric field will move in the same direction as the arrow representing the electric field A free electron under the influence of an electric field will move in a direction opposite to the arrow representing the electric field.

33. The holes in the emitter are accelerated towards the emitter-base junction by the positive voltage of the emitter battery (Ecc). Some of mthe holes have momentum enough to "over-ride" the reduced junction field and pass into the base. The base is very thin and most of the holes move across the base under their own momentum to the beginning of the increased collector-base total electric field. The holes are "swept" across the collector-bas junction by its field and then on out to the collector terminals by the negative collector terminal voltage.

34. In practical circuits you can measure the voltage at each transistor element and mooting the magnitude and polarities, you can determine if the transistor is conducting or cut-off. Using the knowledge you have obtained determine the condition of the transistor in Fig-10.

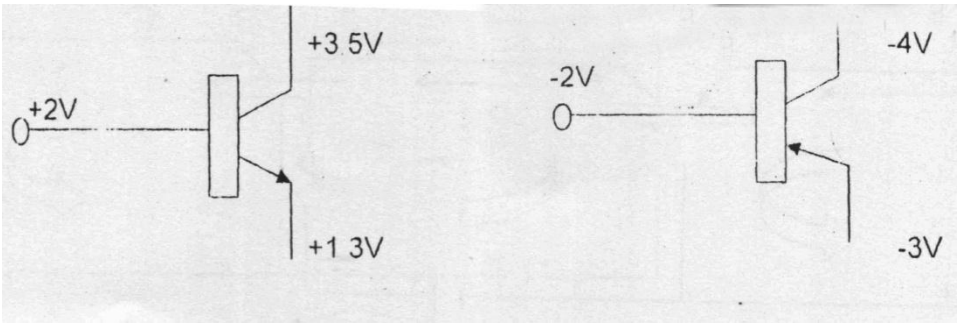


Fig-11

35. In Fig-11 the NPN transistor is conducting. The base is more positive than the emitter so the E-B junction is forward biased. Note the difference in potential across the conducting E-B junction is 0.17 volts, the forward voltage drop of a silicon diode. Most modern transistor (diodes and integrated circuits) are silicon device. The base is less positive or more negative than the collector by (3.5-2) = 1.5 volts so this junction is reversed based. Therefore, the transistor is conducting. Is the PNP in Fig-11 conducting or non conducting ? It is non-conducting. Both the E-B and B-C junction are reversed biased so current does not flow from emitter to collector.

Comparison of Basic PNP Action

36. Basic PNP and NPN actions are compared as follows :

a. Both NPN and PNP transistor must have forward biased emitter-base junction and reverse biased collector-base junction in order to operate as an amplifier.

b. In a PNP transistor a positive voltage must be applied to the emitter and in an NPN an negative voltage must be applied to the emitter. In a PNP a negative voltage must be applied to the collector and in an NPN a positive voltage must be applied to the collector.

c. The majority emitter current carriers in the PNP transistor are holes which moves into the base and divides between the base and the collector circuits with most of them transferred of the collector. The majority emitter current carrier in the NPN transistor are free electrons which moves into the base and divides between the base and collector circuits with most of them transferred to the collector.

d. In the NPN the current directions is opposite to the current direction in the PNP transistor. In the NPN transistor the polarities of the base batteries are opposite to those of the PNP transistor.

Measurable Transistor DC Current

37. The actual path for current (electron) flow in a properly biased NPN transistor is shown in Fig-12.

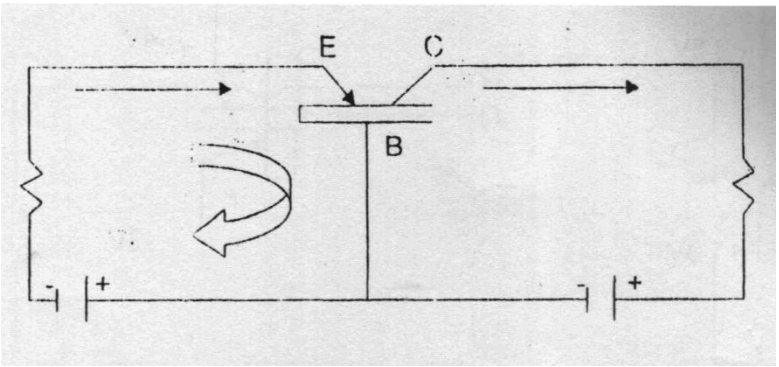


Fig-12 : Current Flow in a Properly Biased NPN Transistor.

38. A large current (Ie) flows into and through the emitter through the base to the

collector Notice that a small amount of current flows out of the base circuit . This current represents the Emitter-Base forward biased diode, and is represented by lb. its magnitude is usually considerably less than that of the emitter current The remaining current (lc) flows out of the collector.

The following equations are written from the preceding paragraph.

e =Ic+lb.....eq (1)

where : lc = the measurable emitter current
lc =the measurable collector current
lb =the measurable base current.

39. The se three current can be measured in an operating PNP or NPN transistor circuit by inserting a de ammeter in series with the respective leads.

40. The collector current (lc) in really is very nearly equal to the emitter current (lc) but is less than the emitter current by an amount equal to the base current (lb). Normally you would expect current to flow in the E-B circuit because this junction is forward biased. But you would not normally expect current to flow in the collector because the B.C junction is reverse biased. The electrons flowing in the emitter enter the base. Here some of the electrons combine with holes in the P-type base and create the current floe out of the base. However, most of the electrons pass on through the base and into the collector. The reason for this is that the base is extremely thin and has only a minimum of available carriers to support current flow. The electron passing through the base are then attracted by the positive charge on the collector. Most of the electrons in the emitter pass through the thin base into the collector and become collector current. A few electrons do not combine with holes to produce a small base current.

41. The current carriers in a PNP transistor are holes rater than electrons. Internally the holes flow from positive to negative External to the transistor the current is electron flow as indicated by the dashed lines. The internal hole currents have the same relationship as electron flow the NPN device. Fig-13 shown electrons and hole flow in a properly biased PNP transistor.

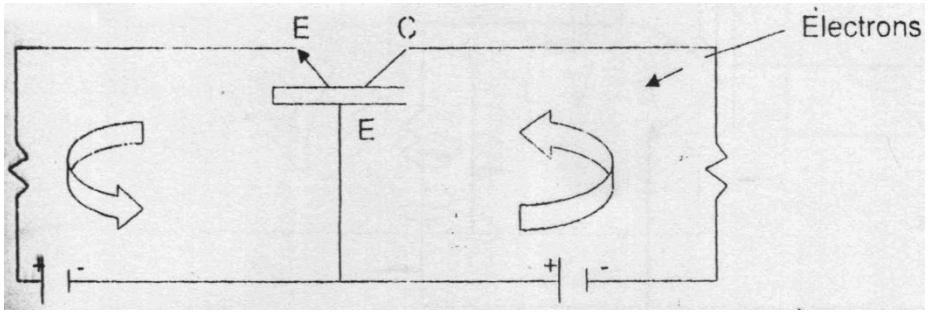


Fig-13 Electron and hole flow in a properly biased PNP transistor.

42. In Fig -13 assume the emitter current to be 4 ma and the collector current to be 3.85 ma, what is the base current? The base current is the difference between the emitter and collector current or

lb = e - lc
lb = 4.0 - 3.85 = 0.15 ma 150 A.

43. The ratio of the collector to emitter current is approximately one because in most cases the collector current is very nearly equal to the miter current. This ratio is called forward current gain (a or alpha).

$$a = \frac{Ic}{Ie} \quad \text{..... eq. 2}$$

44. Practical value of alpha run in the 0.95 to 0.99 range. The higher the gain the better the transistor. Using the value just stated above, calculate the value of current gain.

$$a = \frac{2.85}{0} = 0.9625$$

45. Fig-14 below shows another way of connecting the bias to a transistor.

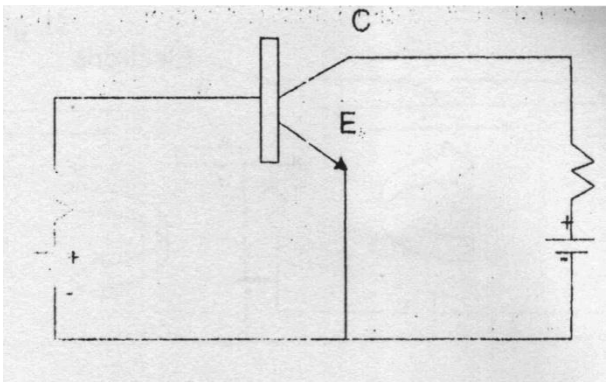


Fig-14 Biasing an NPN transistor with a common emitter connection.

46. Note that the emitter is the common element for the supply voltages rather than the base in the previous arrangement. The transistor will conduct because the E-B junction is forward biased and B-C junction is reverse biased. The reverse bias on condition can be readily see it you consider the voltage on the base. With the E-B junction forward biased the base is 0.7 volt. For this reason the base is less positive or more negative than the collector, thus the reverse bias.

47. In Fig-15 the relationship between the various current flowing is :

$$Ie = Ib + Ic$$

The base and collector combine at the emitter to form the emitter current. The relations expressed above hold true to any transistor in any bias circuit configuration. Since both the bias voltage (Eb& Ec) voltage Eb and Ec are positive with respect to the emitter as shown in Fig-15 then they can be replaced by a singe supply battery as shown in Fig-16. The result is proper bias for conduction at a considerable saving in the power supply. the valve of Rb are adjusted to provide the desired current levels. The bias voltage is labeled Ecc and is called the collector supply.

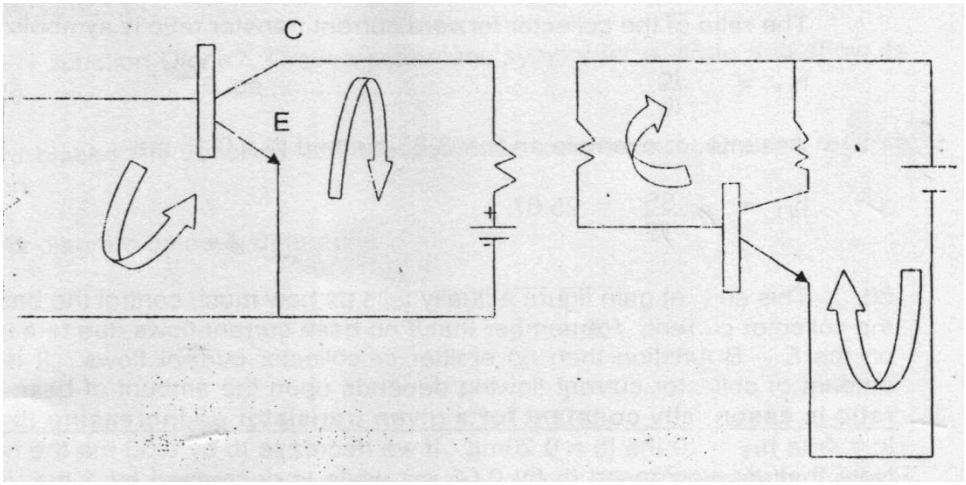


Fig-15 current flow in a common emitter biasing circuit

Fig-16 simple voltage bissing of an NPN transistor

The common Emitter Amplifier.

48. The common emitter amplifier arrangement is one in which the ac or signal voltage is applied between the base lead and ground with the output being taken form the collector. The common emitter is capable of both voltage and current gain. Figures 15 & 16 are representative of a common emitter circuit.

The Beta (B) or HFE of a Transistor

49. Earlier the alpha of a transistor was defined as the emitter to collector forward current transfer ratio. The portion of the emitter current than does not transfer to the collector is cased the recombination current :

Ir = Ie (alpha) Ie.....eq. 3

Neglect in ICBO

Ib = Ir ..... eq. 4

The ratio of the collector forward current transfer ration is symbolized as "B" or hFE.

$$hFE = \frac{Ic}{} \quad \text{..... eq.4}Ib$$

Assume for example an Ic = 3.85 ma and Ib = 0.15 ma.

$$hFE = \frac{3.85}{15} \quad 25.67$$

50. This current gain figure actually tells us how much control the base current has over the collector current. Remember that if no base current flows due to a lack of forward bias on the E - B junction then no emitter or collector current flows. It is also ture that the amount of collector current flowing depends upon the amount of current. **The Ic/Ib ratio is essentially constant for a given transistor so increasing Ib by a factor** hFE. If Ic = 4ma hFE = 20 the Ib = 0.20mg. If we decrease Ib by 0.50 ma the new Ic will be 3 ma. Note that we decreased Ib by 0.05 ma while Ic decreased by 1 ma, a 20 to 1 ratio hFE. Therefore you can see that the smaller base current can control the larger collector current.

51. As you change the base current to control the collector current the transistor acts as a variable resistor. A high collector current means a low emitter to collect resistance and a low current represents a high emitter to collector resistance. An increase in the base current causes the emitter collector resistance to decrease. Increasing lb increases lc so that the transistor conducts more and appears as a lower resistance.

52. The transistor can also be used as an on-off switch. If no base current is applied, no collector current flows so the transistor is cut-off. It acts as an open switch. If a high base current is applied, the transistor conducts and acts like a very low resistance. The transistor appears as a closed switch. In this section on digital techniques, the transistor will be considered as a switch.

Consolidation Exercise - 1

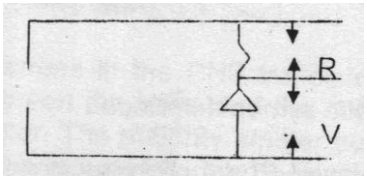
Q1. What is a PN Junction Diode ? Draw a schematic symbol for a diode and show its anode and cathode.

Q2. In a forward biased PN Junction how the potentials connected? Draw a reverse biased PN Junction.

Q3. Consider the diagram below & determine.

Vn = ?

VR = ?



Q4. What are the three electrodes of a transistor known as? Draw schematic symbols for transistor showing the difference between a PNP and an NPN transistor.

Q5. Compare the basic PNP and NPN action of transistors.

Q6. For successful operation of a transistor it has to be properly biased. Show a properly biased transistor configuration along with measurable DC current.

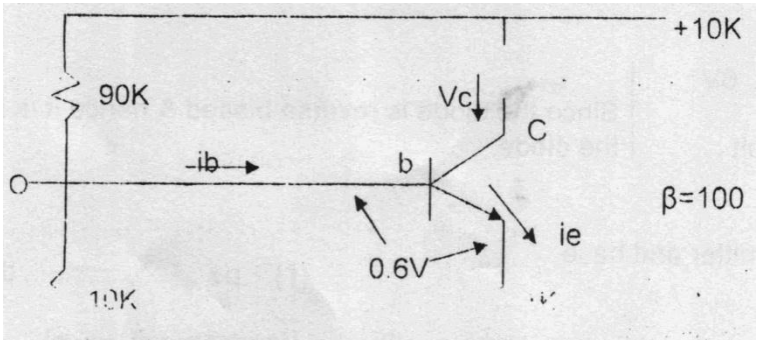
Q7. What do you understand by current gain (beta) ? Write down the relationships the measurable DC current.

Q8. Consider the diagram below and determine approximately.

Vc = ? ie = ?

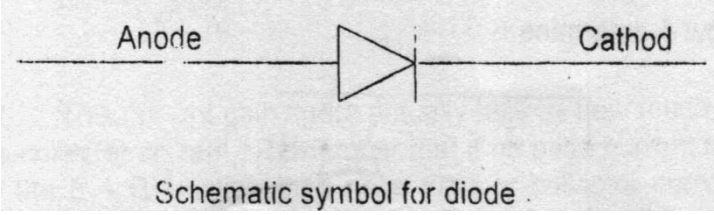
Vb = ? ic = ?

Va = ? ib = ?



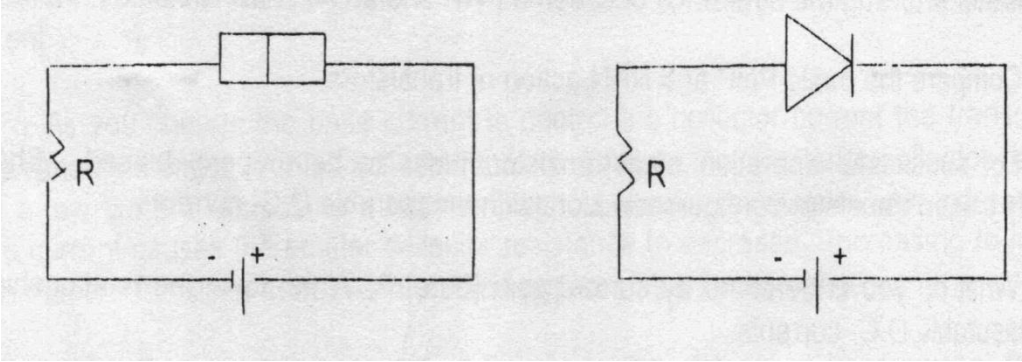
Answers to Consolidation Exercise - 1

A1. A junction diode is simply a bar of either silicon or germanium employing P doping in one section and N doping in the other.



Schematic symbol for diode

A2. In a forward biased PN junction the positive polarity is connected to the P section while the negative polarity is connected to the N-section.



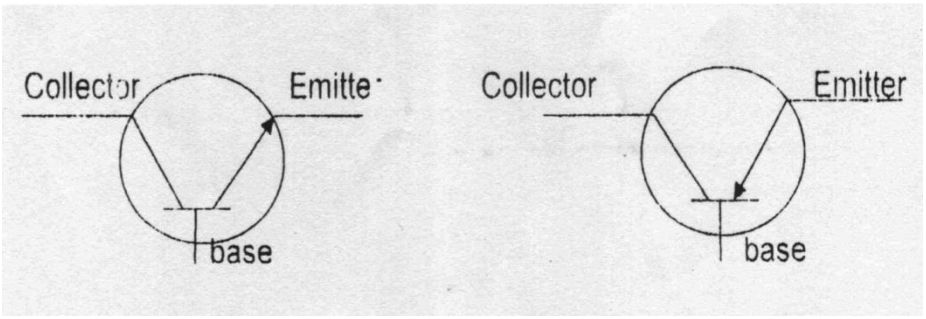
A reverse biased PN junction

A3. Vd E = 6V

VR O volt

Since the diode is reverse biased and hence it is open- circuit at the diode.

A4. Collector, emitter and base.



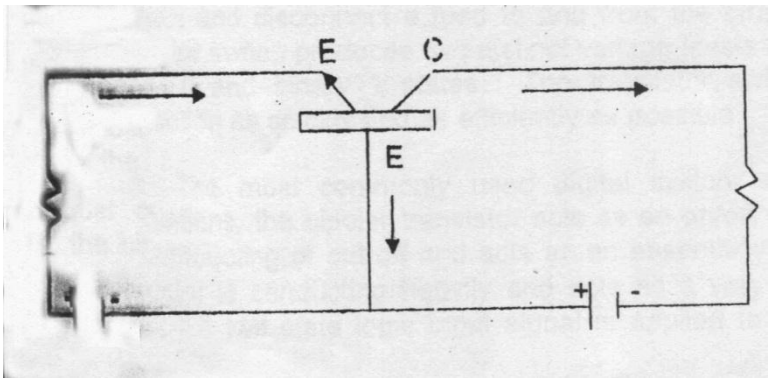
A5. **Comparison of Basic PNP and NPN Action**

a. Both NPN and PNP transistor must have forward biased emitter-base junction and reverse biased collector-base junction in order to operate as an amplifier.

b. In a PNP transistor a positive voltage must be applied to the emitter and in an NPN a negative voltage must be applied to the emitter. In a PNP a negative voltage must be applied to the collector and in an NPN a positive voltage must be applied to he collector.

c. The majority emitter current carriers in the PNP transistor are holes which move into the base and divides between the base and the collector circuits with most of them transferred to the collector. The majority emitter current carrier in the NPN transistor are free electrons which moves into the base and divides between the base and collector circuits with most of them transferred to the collector.

d. In the NPN the current directions is opposite to the current direction in the PNP transistor. In the NPN transistor the polarities of the base batteries are opposite to those of the PNP transistor.



A6.

Ie = Ic + Ib.....Eq (1)

where : Ie = the measurable emitter current.
Ic = the measurable collector current.
Ib = the measurable base current.

TASK - 7

PULSE AND DIGITAL CIRCUITS

Introduction

1. Pulse and Digital circuits are widely used almost in all types of electronics circuits today. The modern Digital Computers are solely made up to these circuits. In this task we shall discuss some of the pulse and Digital circuits that are being commonly used. Although Digital circuits could be made up of the good old vacuum tubes, relays and switches, these are no longer preferred for reasons of size, efficiency and economy. Transistor and integrated circuits have almost replaced them as such, only semiconductors will be discussed more.

Transistor Switch

2. The basic component used in implementing any digital logic circuit is a switch. Modern digital integrated circuits use a high speed transistor switch as the primary components. There are two basic types of transistors used in implementing digital integrated circuits, the **bipolar transistor** and the metal oxide semiconductor field effect transistor (MOSFET).

3. The primary function of a transistor switch in a digital logic circuit is to alternately connect and disconnect a load to and from the circuit power supply. In doing this the transistor switch produces two district voltage levels across the load which represents the binary 0 and binary 1 state. The transistor switch should make and break these connections as quickly and efficiently as possible.

4. The most commonly used digital switch is the bipolar transistor. In digital applications, the bipolar transistor acts as an on/off switch. In one state the transistor is non-conducting or cut-off and acts as an essentially open circuit. In the other state, the transistor is conducting heavily and acts as a very low resistance approaching a short circuit, a two state logic input signal is applied to the transistor to produce the on/off operation.

Modes of Operation

5. A bipolar transistor has three basic region of operation:

   a. Cut-off.

   b. Linear or active.

   c. Saturation

All three modes are used in digital circuits, the cut-off and non-saturated bipolar circuits and the cut-off and saturation modes in saturated bipolar circuits.

Cut-Off

6. In the cut-off mode the transistor is non-conducting. Both the emitter-base and collector-base are **reversed biased or not biased at all the produce the cut-off state.** In theory, no emitter or collector current flow, and the transistor acts as an open circuit between emitter and collector. In most circuits, the cut-off is not perfect because of the imperfection in the semiconductor material out of which the device is made, some leakage current flows. In most modern transistors this leakage current is extremely low and for most practical application can be neglected.

7. The linear or active mode is characterized by a forward biased emitter-base junction and a reverse biased collector-base junction. In other word this represents the normal operation of a transistor. In this mode, the transistor conducts. Emitter and collector current flows. The emitter and collector current are directly proportional to the base current are directly proportional to the base current variations in this mode of operation the transistor functions as a variable resistor and is used to amplify signals.

Saturation Mode

8. The third mode of bipolar operation is saturation In this mode both the emitter base and collector-base are forward biased. The transistor conducts heavily and action as a very resistor. The resistor between the emitter and collector is very low approaching that of a short circuit.

9. In digital applications the transistor are employed mainly as a switch. As switches the transistor passes quickly through the linear regain. The primary responsibility of the designer of a digital circuit is to see that the bipolar transistor switches as quickly as possible between cut -off and saturation and that these two stales are as stable as possible.

Switching Speed

10. In logic circuits the ability to switch rapidly between the binary logic levels is one of the most important criteria that must be met. The switching speed is affected by:

a. Transistor characteristics.

b. Circuit component values.

c. Stray capacitance and in and inductance.

d. Current and voltage even in the circuits.

e. Specific circuit configuration.

11. When the input signal to a digital circuits changes from one logic level to the other the output of the circuit does not change instantaneously in the response. Instead there is a delay time existing between the change in the input signal and the corresponding change in the output. This time lag is generally referred to as propagation delay.

12. The **turn of time** of a transistor is primarily a function of the transistor characteristics and the amount of base drive applied to the circuit. A heavy base current helps to ensure a rapid turn-on.

13. The **turn-off time** delay is affected mainly by the transistor characteristics. The turn off of the transistor is delayed because of **storage time**. When a transistor is saturated, an excess of minority carriers (holes in a NPN and free electrons in an PNP transistor) build up in the collector-base junction region. This charge storage keeps the transistor conducting **even** with the base drive removed. It takes a finite period of time for this charge to be removed so that the transistor characteristics and base drive.

Saturated Switching Circuits

14. The most common form of bipolar transistor logic switch is shown in Fig-22. Here the transistor is connected as a shunt switch since it is parallel with the output lead RL . This circuit is also known as a **transistor logic inverter.**

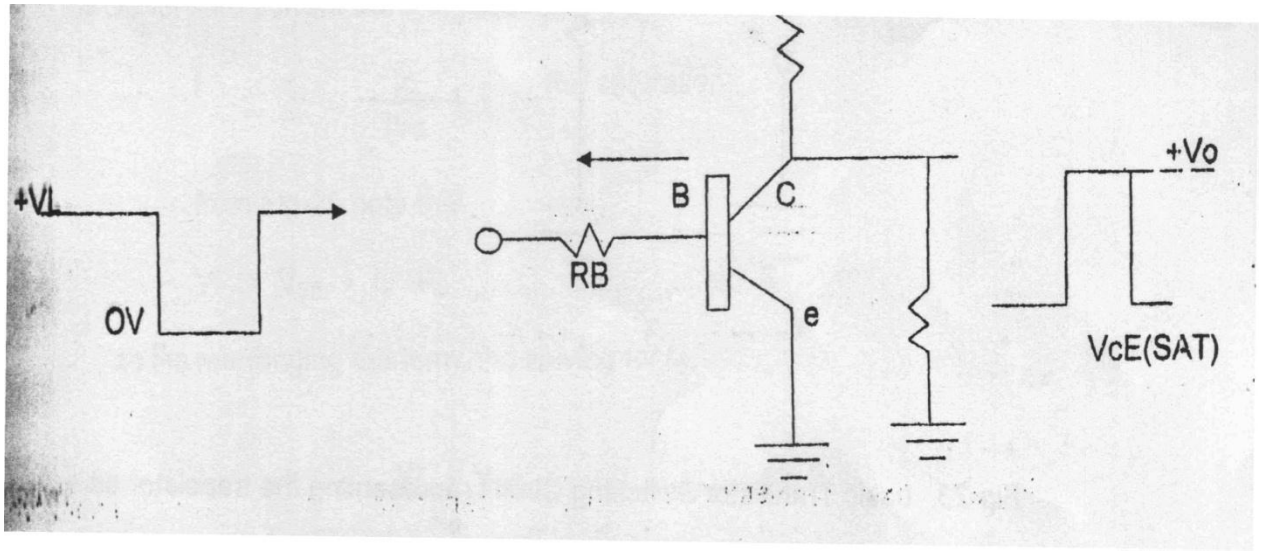


Fig-22. Basic Transistor Switching Circuits.

15. With an input voltage Vi o zero or ground, the transistor is cut-off. The emitter base junction is not forward biased, therefore the transistor does conduct. The only collector current flowing at this time is a minute leakage current. Analysis of the circuit is as follows :

a. With an input voltage Vi = 0 volt or ground, the transistor is cut-off. The transistor does not conduct and therefore if you look at the transistor as switch, it is an open switch.

b. With no lead, (NOFL) the output voltage Vo = Vcc as seen through the collector resistor Rc.

c. If a finite load resistor RL is connected between the output a ground Vo will be some value less than Vcc and depends upon the division ratio between Rc and RL. From Fig-23.

$$It = \frac{Vcc}{Rc + RL}$$

$$Vo = It \times RL$$

$$\text{Therefore, } Vo = \frac{RL}{Rc+RL} \times Vcc$$

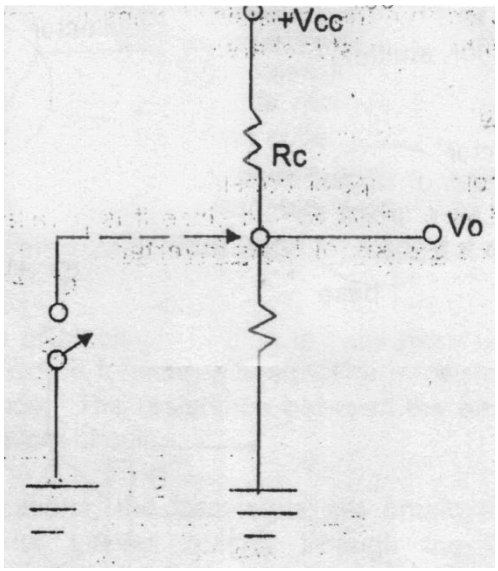


Fig - 23 . basic Transistor Switching Circuit representing the transistor as a switch.

d. When an input voltage Vu of sufficient amplitude is applied to base resistor RB, the emitter-base junction will become forward biased and the transistor will conduct. The transistor will be in the linear or saturates state depending upon the size of Vi, the value of RB and the gain (b or h) of the transistor.

e. Referring to Fig-23, Imagine the switch as being closed. In this condition volt terminal would be placed at ground potential by the transistor (virtually short circuit when it is conducting). As a result output voltage Vo would be nearly equal to zero volts.

16. Fig-24. shows the typical input and output waveforms of a transistor switching circuit. The input switches between zero volt (Low) and Vi (high). When the input is **low**. The transistor is cut-off so you see and output voltage Vo that is equal to Vcc or some value slightly less (high). When input is **high** or equal to Vi the transistor conducts to saturation and act as a low resistance. The output voltage Vo is the collector-emitter saturation voltage Vcc (sat) which is only a few tenth of a volt (low).

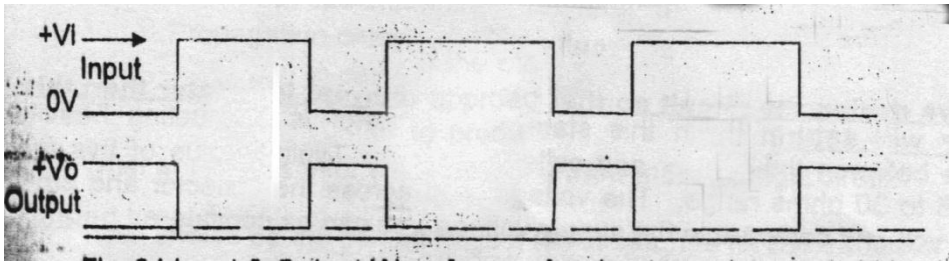


Fig- 24 Input & Output Waveforms of a shunt transistor switching circuit.

17. To cause the transistor to saturate sufficient base current must flow. This condition occurs when the actual base current lB is greater than the ratio of the collector current IC to he DC forward current transfer ratio hFE.

$$I = \frac{Ic}{hFE} \quad \text{(for saturation)}$$

from Fig-25 note that :

$$Vi = VBE + Is\ Rs \quad \text{.....eq. 8}$$

So the rearranging the term and solving for ls.

$$lB = \frac{VI - VBE}{RB} \quad \text{.....eq .9}$$

Where VBE ls the voltage across the forward biased emitter-base junction.

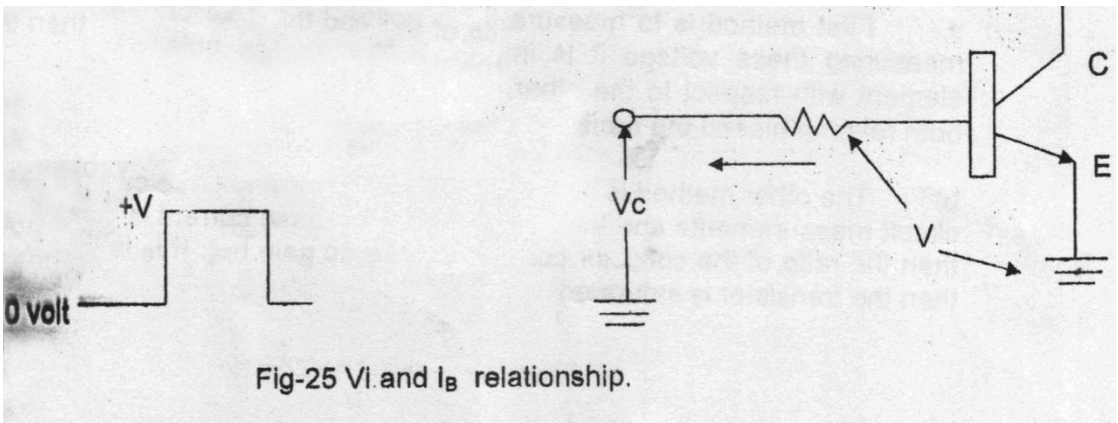


Fig-25 Vi and I_B relationship.

18. As you can recall hFE = and this expression ls and indicative of the effective gain of the device or the ability of the base current to control the larger collector current. The greater this ratio the higher the gain. Therefore from expression above.

$$lB = \frac{Ic}{hFE} \quad \text{..... eq.10}$$

19. **If we design the circuit so that the base current is greater than this ratio the transistor with saturate**. In this state the transistor is conducting heavily and the resistance between the emitter and collector is low. Typical value of this resistance is between 5 to 30 ohms range. The voltage drop across the collector and emitter is only tenth of a volt and compare to the supply voltage Vcc can be considered **negligible**.

20. During saturation the amount of collector and emitter current flowing becomes basically a function of the value of power supply voltage Vcc and collector resistance Ro. Because the voltage drop across the transistor basically zero, the collector current can be found from :

$$Ic = \frac{Vcc - VCE - (Sat)}{Rc} = \frac{Vcc}{Rc} \quad \text{..... eq.11}$$

21. This relationship holds true only if sufficient base current flows the saturate the transistor. **If the value of the base current is less than the ratio of Ic and hEF (See eq.10) the transistor will be operating in the linear region**.

Test for Saturation

22. Basically there are two ways you can determine whether a transistor is saturated or not :

a. First method is to measure the junction potentials on the transistor. When measuring these voltages it is important to note the polarity of each transistor element with respect to the other. When the emitter-base and collector-base are both reverse biased the transistor ls operating at the saturation mode.

b. The other method is found both the collector and base current through actual circuit measurements and then determine if the base current is less that or greater than the ratio of the collector current and the dc gain hFE. If lB is greater than lc/hFE then the transistor is saturated.

Consolidation Exercise - 2

Q1. Bipolar transistors are widely used in pulse and digital circuits. The bipolar transistor has three basic reign of operation. What are these ?

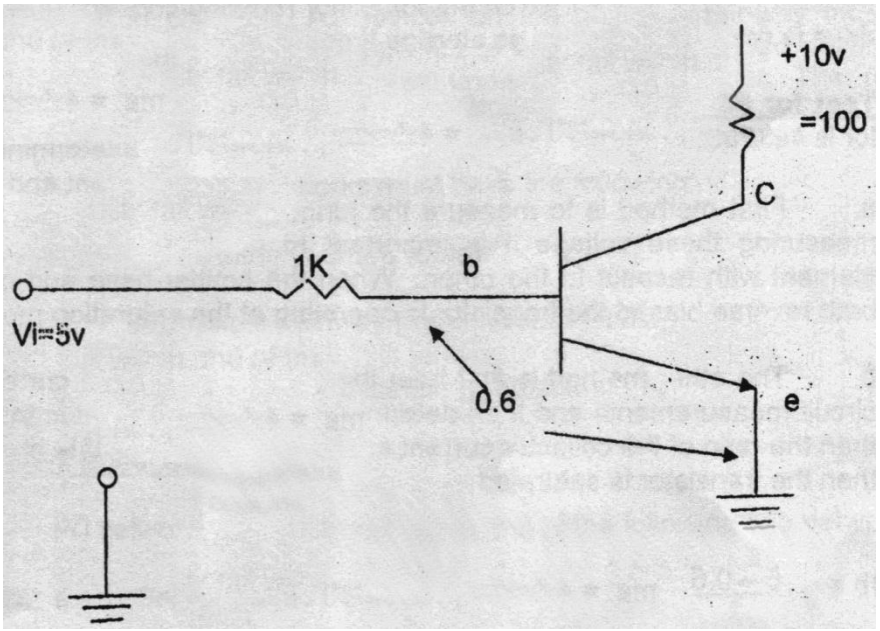
Q2. Define :

a. Propagation delay.

b. Storage time.

Q3. What are the tests for saturation of a transistor in a logic circuit ?

Q4. What should be the minimum gain (B) to saturate for the transistor shown below:



Answer to Consolidation Exercise - 2

A1. a. Cut - off

b. Linear or active.

c. Saturation.

A2. a. **Propagation Delay**. When the input signal to a digital circuit changes from one logic level to the other, the output does not change instantaneously in the response. The delay time existing between the input and corresponding output signal is referred as propagation delay.

b. **Storage Time**. When a transistor is saturated an excess of minority carriers build up in the collector base junction region which tend to delay the turn off of the transistor. The time for which the transistor romaine conductive even after the base drive is removed is known as storage time.

A3. **Test for Saturation**. Basically there are two ways you can determine whether a transistor is saturated or not.

a. First method is to measure the junction potentials on the transistor. When measuring this voltage it is important to note the polarity of each transistor element with respect to the other. When the emitter-base and collector-base are both reverse biased the transistor is operating at the saturation mode.

b. The other method is find both the collector and base current through actual circuit measurements and then determine if the base current is less than or greater than the ratio of the collector current and the DC gain hFE. If lB is greater that lc/hFE then the transistor is saturated.

Q4. lb = $\frac{5-0.6}{1}$ ma = 4.4 ma

Vce (Sat) = 0.3 volt (approx).

Voltage across RL = to saturate is

VR = 10-0.3 = 9.7 volts and

lRL = $\frac{9.7}{100}$ = 97 ma

$\frac{97}{4.4}$ ma

TASK-8

COMPUTER FUNDAMENTAL AND NETWORKING

Introduction

1. The explosive growth of the networking is a revolutionary phenomenon in computing and telecommunication. The computer network has become the largest and most important network of networks today and has evolved into a global information superhighway. It is constantly expanding, as more and more businesses and other organization and their users, computers and networks join its global web. It has also become a key platform for a rapidly expanding information and entertainment services.

What is network

2. A Network is a set of devices (often referred to as nodes) connected by media links. A device or node can be a computer, printer, or any other device capable of sending and/or receiving data generated by other nodes on the network. The individual device must be connected through a physical pathway which is often called communication channels. All devices on the physical pathway must follow a set of common communication rules for data to arrive at its intended destination and for the sending and receiving systems to understand each other. The rules that govern computer communication are called protocols.

3. In summary, all networks must have the following :

   a. Something to share (data).

   b. A physical pathway (transmission media).

   c. Rules of communication (protocols).

Network Model Configuration

4. PC networks generally fall within one of the following two network types :

   a. Server-based network.

   b. Peer-to-peer network.

Server-Based Network

5. A server-based network consists of a group of user-oriented PCs (called clients) that request and receive network services from specialized computers called servers. Servers are generally higher-performance systems, optimized to provide network services those PCs. Some common server types include web servers, file servers, file servers, mail servers, print servers, fax servers and database servers.

Peer-to-peer Network

6. A peer-to-peer network is a group as user oriented PCs that basically operate as equals. Each PC is called a peer. The peers share resources, such as files and printers, but no specialized servers exist. In this network, each peer is both clients (because it requests services from other peers) and a server (because it offers services to there other peers). Many network environments are a combination of server-based and peer-to-peer networking models.

Line Configuration of Network

7. Line configuration refers to the way two or more communication devices attach to a link. A link is the physical communication pathway that transfers data from one device to another. For the purposes of visualization, it is simplest to imagine any link as a line drawn between two points. For communication to occur, two devices must be connected in some way to the same link at the same time. There are two possible line configurations:

a. **Point-to-Point**. A point-to-point line configuration provides a dedicated link between two devices. The entire capacity of the channel is reserved for transmission between those two devices. Most point-to-point line configurations use an actual length of wire or cable to connect the two ends, but an example, when we change TV channels by infrared remote control and the television's control system.

b. **Multipoint**. A multipoint line configuration is one in which more than two specific devices share a single link. In a multipoint environment, the capacity on the channel is shared. As an example a channel of mobile repeater and mobile set may nbe used for voice, data and graphics.

Network Topology

8. The term topology refers to the way a network is laid out, either physically or logically. Two or more devices connect to a link; two or more links form a topology. The topology of a network is the geometric representation of the relationship of all the links and linking devices (usually called nodes) to each other. There are five basic topologies possible; mesh, star, tree, bus and ring.

a. **Mesh Topology**. In a mesh topology, every device has a dedicated point-to-point link to every other device. The term *dedicated* means that the link carries traffic only between the two devices it connects. A fully connected mesh network therefore has *n(n-1)/2* physical channels to link n devices. To accommodate that many links, every device on the network must have n-input/output (I/O) ports.

b. **Star Topology**. In a star topology, each device has a dedicated point to point link only to a central controller, usually called a hub. The devices are no linked to each other. Unlike a mesh topology, a star topology does not allow direct traffic between devices. The controller acts as an exchange. If one device wants to send data to another, it sends to the controller, which then relays the data to the other connected devices.

c. **Tree Topology**. A tree topology is a variation of a star. As in a star nodes in a tree are linked to a central hub that controls the traffic to the network. However, not every device plugs directly into the central hub. The majority of devices connect to a secondary hub that in turn is connected to the central hub. The central hub in the tree is an active hub; an active hub contains a repeater, which is a hardware device that regenerates the received bit patterns before sending them out. Repeating strengthens transmissions and increases the distance a signal can travel between sender and receiver.

d. **Bus Topology**. A bus topology, on the other hand, is multipoint. One long cable acts as a backbone to link all the devices in the network. Nodes are connected to

the bus cable by drop lines and taps. A drop line is a connection running between the device and the main cable. A tap is a connector that either slides into the main cable or punctures the insulation of a cable to create a contact with the metallic core. As a signal travels along the backbone, some of its energy is transformed into heat. Therefore, it becomes weaker and weaker the further it has to travel. For this reason there is a limit on the number of taps a bus can support and on the distance between those taps.

e. **Ring Topology**. In a ring topology, each device has a dedicated point-to-point line configuration only with then two devices on either side of it. A signal is passed along the ring in one direction, from device to device, until it reaches its destination. Each device in the ring incorporates a repeater. When a device receives a signal intended for another device, its repeater regenerates the bits and passes them along.

f. **Hybrid topology**. Often a network combines several topologies as sub networks linked together in a larger topology. For instance, one department of a business may have decided to use a bus topology while another department has a ring. The two can be connected to each other via a central controller in a star topology.

Categories of Networks

9. Today when we speak of networks, we are generally referring to three primary categories: local area networks (LANs), metropolitan area networks (MANs) and wide area networks (WANs). Which category a network falls into is determined by its size, its ownership the distance it covers, and its physical architecture.

a. **Local Area Network (LAN)**. LAN is usually privately owned and links the devices in a single office, building or campus. Depending on the needs of an organization and the type of technology used, a LAN can be as simple as two PCs and a printer in someone's home office, or it can extend throughout a company and include voice, sound, and video peripherals. Currently, LAN size is limited to a few kilometers.

b. **Metropolitan Area Network (MAN)**. MAN is designed to extend over an entire city. It may be a single network such as a cable television network, or it may be a means of connecting a number of LANs into a larger network so that resources may be shared LAN-to-LAN as well as device-to-device. MAN may be wholly owned and operated by a private company, or it may be a service provided by a public company, such as a local telephone company.

c. **Wide Area Network (WAN)**. WAN provides long distance transmission of information over large geographical areas that may comprise a country, a continent, or even the whole world.

Internet Works

10. When two or more networks are connected, they become an internet work, or internet. Individual networks are joined into internet works by the use of internetworking devices. The term internet should not be confused with the internet. The first is generic term used to mean an interconnection of networks. The second is the name of a specific worldwide network.

Protocol

11. In computing a protocol is set of rules which is used by computers in communicate with each other across a network. A protocol is a convention or standard that controls or enables the connection, communication, and data transfer between computing endpoints. In its simplest form, a protocol can be defined as the rules governing the syntax, semaritics, and synchronization of communication. Protocols may be implemented by hardware, software, or a combination of the two. At the lowest level a protocol defines the behavior of a hardware connection.

Networking and Internetworking Devices

12. Two or more devices connected for the purpose of sharing data or resources are stations on a network. A network may need to cover more distance that its media can handle effectively. Or the number of stations may be too great for efficient frame delivery or management of the network and the network may need to be subdivided. In the first case, a device called a repeater or regenerator is inserted into the network to increase the coverage the coverable distance. In the second, a device called a bridge is inserted for traffic management. When two or more separate networks are connected for exchanging data or resources, they become an internetworks (of internet). Linking the number of networks into an internet requires additional internetworking devices called routers and gateways. These devices are designed to overcome obstacles it interconnection without disrupting the independent functioning of the networks.

a. **Repeaters**. A repeater is an electronic device that operates on only the physical layer of the OSI model. Signals that carry information within a network can travel a fixed distance before attenuation (weakening of the signal due to friction) or interference from noise endangers the integrity of the data. A repeater installed on a link receives the signal before it becomes too weak or corrupted regenerates the original bit pattern, and puts the refreshed copy back onto the link. In effect, the signal, with the corruption removed, is transmitted a second time from a location closer to the destination.

b. **Bridge**. Bridge divides a large network into smaller segments. It can also relay frames between two originally separate segments of one type. Unlike repeaters, bridges contain logic that allows them to keep the traffic for each segment separate. Bridges are repeaters that are smart enough to relay a frame only to the side of the segment containing the intended recipient. In this way they filter traffic, a fact that makes them useful for controlling congestion and isolating problem links. Bridges can also provide security through this partitioning of traffic.

c. **Routers**. Repeaters and bridges are simple hardware devices capable of executing specific tasks. Routers are more sophisticated. They have access to network layer addresses and contain software that enables them to determine which of several possible paths between those addresses the best for a particular transmission is.

d. **Gateways**. A gateway is a protocol converter. A router by itself transfers, accepts and relays packets only across networks using similar protocols. A gateway, on the other hand can accept a packet formatted for one protocol (e.g. Apple Talk) and convert it to a packet formatted for another protocol (e.g. TCP/IP) before forwarding it. A gateway is generally software installed with in router. The gateway understands the protocols used by each network linked into the router and is therefore able to translate from one to another. In some cases, the only modifications necessary are the header and trailer of the packet. In other cases, the gateway must adjust the data rate, size, and format as well.

Different Types of MODEM

13. There are two types of networking connections are used :

a. By direct cable connection.

b. By using different type of modems.

14. NIC card (Network Interface Card) is used for the direct cable or fiber optic cable connection. Modem means modulation demodulation. There are mainly two types of modems used to connect distant clients with the server of a network. These modems are:

a. **DSL Modem**. Digital subscriber line modem can be used for multiple users. Hub and switches are used to connect up to 16 clients with DSL modem. The speed is 04 KB to 02 MB.

b. **Data Fax Modem**. This modem is also known as dial up modem (External & Internal). This modem is used for single client. The speed is 04 to 56 KB.

Connectors and Cables for Networking

15. According to the types of cables following 03 types connectors are used:

a. For UTP cable RJ-45 connector

b. BNC for Coaxial cable

c. Cord connector for Fiber optics cable.

16. Earlier straight pair cable including telephone cables and coaxial cable were using for networking. Now a days UTP (Unshielded Twisted Pair) cable are widely used for small networking. There are different types of UTP cable available in the market but mainly following 02 categories are in use :

a. UTP (Cat-5)

b. UTP (Cat-6)

Internet

17. The **Internet** is a global system of interconnected compute networks that use the standardized Internet Protocol Suite (TCP/IP) to serve billions of users worldwide, is a network of networks that consists of millions of private and public, academic business and government networks of local to global scope that are linked by copper wires, fiber optic cables, wireless connection, and other technologies. The internet carries a vast array of information resources and services. most notably the inter-link hypertext documents of the World Wide Web (WWW) and the infrastructure to supply electronic mail in addition it supports popular services such as online chat, file transfer and file sharing gaming, commerce, social networking, publishing, vide on demand and teleconferencing and telecommunications voice over internet protocol (volt) applications allow person-to-person communication via voice and video.

18. The origins of the internet reach back to the 1960s when the United State funded research projects of its military agencies to build robust, fault-tolerant after distributed computer networks. This research and a period of civilian funding of a U.S backbone by the National Science Foundation spawned worldwide participation the development of new networking technologies and led to the communication of international network in the mid 1990s and resulted in the following popularization of countless applications in virtually every aspect of modern human life. As of 1990, the estimated quarter of Earth's population uses the services of the internet.

19. **Terminology**. The terms *Internet* and *World Wide Web* are often used everyday speech without much distinction. However, the internet and the World Wide Web are not one and the same. The internet is a global data communications system is a hardware and software infrastructure that provides connectivity between computers. In contrast, the Web is one of the services communicated via the internet is a collection of interconnected documents and other resources, linked by hyperlink and URLs.(1) The term the *internet*, when referring to the internet, has traditionally been treated as a proper noun and written with an initial capital letter. There is a trend regard it as a generic term or common noun and thus write it as the "the internet", without the capital.

20. **Governance**. The Internet is a globally distributed network comprises many voluntarily interconnected autonomous networks. It operates without a center governing body. However, to maintain interoperability, all technical and policy aspect of the underlying core infrastructure and the principal name spaces are administered of the Internet Corporation for Assigned Names and Numbers (ICANN), headquartered Marina del Rey, California. CANN is the authority that coordinates the assignment of unique identifiers for use on the Internet, including domain names, Internet Protocol (IP) addresses, application port numbers in the transport protocols, and many other parameters. Globally unified name spaces, in which names and numbers are unique, assigned, are essential for the global reach of the Internet. ICANN is governed by the International board of directors drawn from across the Internet technical, business academic and other non commercial communities. The US government continues have the primary role in approving changes to the DNS root zone that lies at the held of the domain name system. ICANN's role in coordinating the assignment of unique identifiers distinguishes it as perhaps the only central coordinating body on the global Internet. On November 16, 2005 the World Summit on the Information Society, held in Tunis, established the Internet Governance Forum (IGF) to discuss Internet-related issues.

Modern Uses of Internet

21. The Internet is allowing greater flexibility in working hours and location, especially with the spread of unmetered high-speed connections and web applications. The Internet can now be accessed almost anywhere by numerous means, especially through mobile Internet devices. Mobile phones, data cards, handheld game consoles and cellular routers allow users to connect to the Internet from anywhere there is a wireless network supporting that device's technology. Within the limitations imposed by small screens and other limited facilities of such pocket-sized devices, services of the Internet, including email and the web, may be available. Service providers may restrict the services offered and wireless data transmission charges may be significantly higher than other access methods.

22. The Internet has also become a large market for companies; some of the biggest companies today have grown by taking advantage of the efficient nature of lo-cost advertising and commerce through the Internet, also known as e-commerce. It is the fastest way to spread information to a vast number of people simultaneously. The Internet has also subsequently revolutionized shopping-for example, a person can order a CD online and receive it in the mail within a couple of days or download it directly in some cases. The Internet has also greatly facilitated personalized marketing which allows a company to market a product to a specific person or a specific group of people more so than any other advertising medium. Examples of personalized marketing include online communities such as MySpace, Friendster, Orkut, Facebook and others which thousands of Internet users join to advertise themselves and make friends online. Many of these users are young teens and adolescents ranging from 13 to 25 years old. In turn, when they advertise themselves they advertise interests and nobles, which on line marketing companies can use as information as to what those users will purchase online, and advertise their own companies' products to those users. The low cost and nearly instantaneous sharing of ideas, knowledge, and skills has made collaborative work dramatically easier, with the help of collaborative software. Not only can a group cheaply communicate and share ideas, but the wide reach of the Internet allows such groups to easily form in the first place. An example of this is the free software movement, which has produced, among other programs, Linux, Mozilla, Firefox and Open Office.Org.Internet "chat", whether in the form of IRC chat rooms or channels, or via instant messaging systems, allow colleagues to stay in touch in a very convenient way when working at their computers during the day. Messages can be exchanged even more quickly and conveniently than via e-mail. Extensions to these systems may allow files to be exchanged, "whiteboard" drawings to be shared or voice and video contact between team members.

23. Version control systems allow collaborating teams to work on shared sets of documents without either accidentally overwriting each other's work or having members wait until they get "sent" documents to be able to make their contributions. Business and project teams can share calendars as well as documents and other information. Such collaboration occurs in a wide variety of areas including scientific research, software development, conference planning, political activism and creative writing. Social and political collaboration is also becoming more widespread as both Internet access and computer literacy grow. From the flash mob 'events' of the yearly 2000s to the use of social networking in the 2009 Iranian election protests, the Internet allows people to work together more effectively and in many more ways than was possible without it.

24. The Internet allows computer users to remotely access other computers and information stores easily, wherever they may be across the world. They may do this with or without the use of security, authentication and encryption technologies, depending on the requirements. This is encouraging new ways of working from home, collaboration and information sharing in many industries. An accountant sitting at home can audit the books of a company based in another country, on a server situated in a third country that is remotely maintained by IT specialists in a fourth. These accounts could have been created by home-working bookkeepers, in other remote locations, based on information e-mailed to them from offices all over the world. Some of these things were possible before the widespread use of the internet, but the cost of private leased lines would have made many of them infeasible in practice. An office worker away from their desk, perhaps on the other side of the world on a business trip or a holiday, can open a remote desktop session into his normal office PC using a secure Virtual Private Network (VPN) connection via the internet. This gives the worker complete access to all of his or her normal files and data, including e-mail and other applications, while away from the office. This concept is also referred to by some network security people as the Virtual Private Nightmare, because it extends the secure perimeter of a corporate network into its employees' homes.

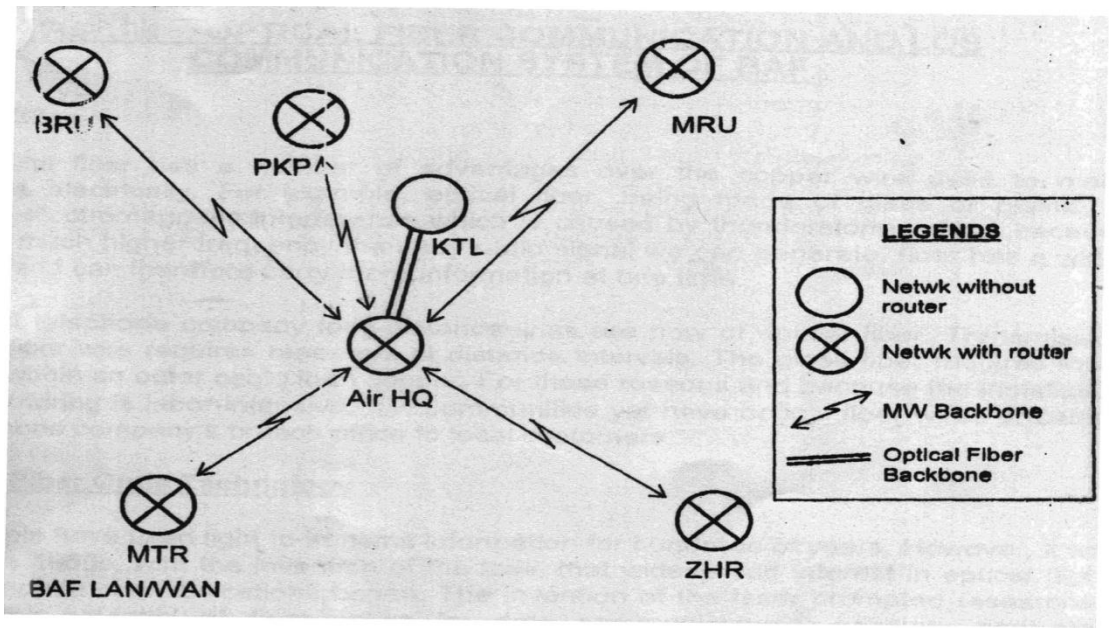
BAF LAN/WAN

25. BAF LAN/WAN sys is the intranet connecting all the BAF Bases and Units around Bangladesh. Main back bone of the WAN is Microwave (MW). Some portion of it is connected via Optical Fiber.

26. **Different LAN**. There are 07 x LAN connected by 07 x Routers. The router at BAF Comm (U) functions as central router.

Ser No	LAN	Router Location	Base/Unit	Backbone
1	Air HQ	BAF Comm (U) LOS Sta	Air HQ & BAF BSR	---
2.	KTL	BAF Comm (U) LOS Sta	BAF KTL	Optical Fiber
3.	MTR	C&E Sqn LOS Sta	BAF MTR	MW
4.	ZHR	C&E Sqn LOS Sta	BAF ZHR	MW
5.	PKP	C&E Sqn LOS Sta	BAF PKP	MW
6.	BRU	LOS Sta	BRU	MW
7.	MRU	LOS Sta	MRU	MW

27. **Block Diagram**



29. **Different Servers of BAF LAN/WAN System**. At present BAF is using fol types of servers :

a. **Mail Server in Air HQ**. This server is used for mailing, sending or receiving data/documents among the users of different BAF Bases and Units. This server is running on Linux Operating System (Redhat 9). Free mailing software OpenMail is being used.

b. **Application Server**. Oracle Application Server 10g is installed on Linux Operating System (Redhat Enterprise 4). This server is used for running Forms and Reports for Integrated Customized Software.

c. **Database Server**. Oracle Database Server 10g is installed on Linux Operating System (Redhat Enterprise 4). This server is used for Database of Integrated Customized Software.

d. **FTP Server**. This server is used for uploading URO, BRO and other important files for distribution to all users of LAN/WAN system.

TASK-9

BAF LANWAN

OPTICAL FIBER COMMUNICATION AND LOS COMMUNICATION SYSTEM OF BAF

Introduction

1. Optical fiber has a number of advantages over the copper wire used to make connections electrically. For example, optical fiber, being made of glass or plastic, is immune to electromagnetic interference which is caused by thunderstorms. Also, because light has a much higher frequency than any radio signal we can generate, fiber has a wider bandwidth and can therefore carry more information at one time.

2. Most telephone company long-distance lines are now of optical fiber. Transmission on optical fiber wire requires repeaters at distance intervals. The glass fiber requires more protection within an outer cable than copper. For these reasons and because the installation of any new wiring is labor-intensive, few communities yet have optical fiber wires or cables from the phone company's branch office to local customers.

History of Fiber Optic Technology

3. People have used light to transmit information for hundreds of years. However, it was not until the 1960s, with the invention of the lase, that widespread interest in optical (light) systems for data communications began. The invention of the laser prompted researchers to study the potential of fiber optics for data communications, sensing, and other applications. Laser systems could send a much larger amount of data than telephone, microwave and other electrical systems. The first experiment with the laser involved letting the laser beam transmit freely through the air. Researchers also conducted experiments letting the laser beam transmit through different types of waveguides. Glass fibers, gas-filled pipes and tubes with focusing lenses are examples of optical waveguides. Glass fibers soon became the preferred medium for fiber optic research.

4. Initially, the very large losses in the optical fibers prevented coaxial from being replaced. Loss is the decrease in the amount of light reaching the end of the fiber. Early fibers had losses around 1,000 dB/km to make them impractical for communications use. In 1989, several scientists concluded that impurities in the fiber material caused the signal loss in optical fibers. The basic fiber material did not prevent the light signal from reaching the end of the fiber. These researchers believed it was possible to reduce the losses in optical fibers by removing the impurities. By removing the impurities, construction of low-loss optical fibers was possible. In 1970, Corning Glass Works made a multimode fiber with losses under 20 dB/km. This same company, in 1972, made a high silica-core multimode optical fiber with 4dB/km minimum attenuation (loss). Currently, multimode fibers can have losses as low as 0.5 dB/km at wavelengths around 1300nm.

Principle of Operation

5. An optical fiber is a cylindrical dielectric waveguide (non conducting waveguide) that transmits light along its axis, by the process of total internal reflection. The fiber consists of a core surrounded by a cladding layer, both of which are made of dielectric materials. To confine the optical signal in the core, the refractive index of the core must be greater than that of the cladding. The boundary between the core and cladding may either be abrupt, in step-index fiber, or gradual, in graded-index fiber.

Transmitters

6. Fiber optic transmitters are deices that include an LED or laser source, and signal conditioning electronics, to inject a signal into fiber. The modulated light may be turned or off, or may be linearly varied in intensity between two predetermined levels. Low Emitting Diodes (LEDs) have relatively large emitting area and as a result are not as good light sources as laser diodes. However, they are widely used for short to modern transmission distances because they are much more economical. Laser diodes can count many times more power to optical fiber than LEDs. They are primarily used for applications that require the transmission of signals over long distances.

7. Important performance specifications to consider when searching for fiber optics transmitters include data rate, transmitter rise time, wavelength, spectral width, maximum optical output power. Data rate is the number of data bits transmitted in bits per second. Data rate is a way of expressing the speed of the transceiver. In the approximation of a step function, the transmitter rise time is the time required for a signal change from a specified 10% to 90% of full power. Rise time is a way of expressing the speed of the transmitter. Wavelength refers to the output wavelength of the transcend. The spectral width refers to the spectral width of the output signal.

Receivers

8. Fiber optic receivers are instruments that convert light into electrical signals. The contain a photodiode semiconductor, signal conditioning circuitry, and an amplifier. Fiber optic receivers use three types of photodiodes positive-negative (PN) junctions, position intrinsic-negative (PIN) photodiodes, and avalanche photodiodes (APD). PIN photodiode have a large, neutrally-doped region between the p-doped and n-doped regions. APDs and PIN photodiodes that operate with high reverse-bias voltages. In short wavelength Fiber optic receivers (400 nm to 11000 nm), the photodiode is made of silicon (Si). In the wavelength systems (900 nm to 1700 nm), the photodiode is made of indium ga... arsenide (InGaAs). With low-impedance amplifiers, bandwidth of the receiver is affected by the gain of the amplifier. Typically, fiber optic receivers include a removable adaptor connections to other devices. Data outputs include transistor-transistor logic (TTL), em... coupled logic (ECL), video, radio frequency (RF), and complementary metal o..... semiconductor (CMOS) signals. Also, it uses many types of connectors.

Fiber

9. Fiber is the medium to guide the light form the transmitter to the receiver, classified into two types depending on the way the light is transmitted: multimode fiber is single-mode fiber.

Multimode Fiber

10. Multimode fiber designed to transmit more than one light at a time. Fiber diameter ranges from 50 to 100 micron. Multimode fibers can be divided in to two category Multimode Step-index Fiber and Multimode Graded-index Fiber.

11. In Multimode Step-index Fiber the lights are sent at angles lower than the critical angle or straight (or simply the angle is zero). Any light angle exceed the critical angle will cause it to penetrate through cladding (refracted) and being lost as shown in Figure 1. Obviously light with lower angle which has less number of reflection, reach the end faster than those wish larger angle and this will result in unstable wave light. To avoid this problem there should be spacing between the light pulses, but this will limit the bandwidth and because of that it is used for very short distance.

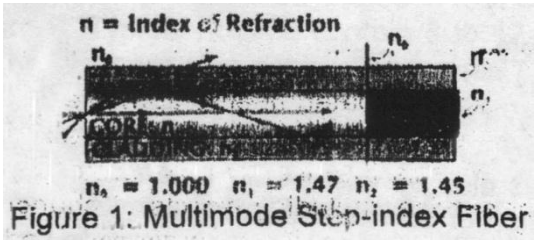


Figure 1: Multimode Step-index Fiber

12. The Multimode Graded-index Fiber designed to reduce the problem in Multimode step-index fiber by making all the beams reaching the receiver at the same time. This can be done by slowing down the ones with shorter distance and increasing the speed for ones with longer distance, see Figure 2. This is done in fiber implementation by increasing its refractive index at the center and gradually decreases it toward the edges. In the Figure 2 we can see the light near the edges is curved until it is reflected, this is due to the refraction caused by the change in density.

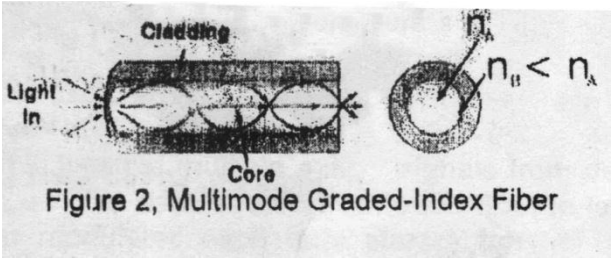


Figure 2, Multimode Graded-Index Fiber

Single Mode Fiber

13. In single-mode only one light is transmitted in the fiber which diameter ranges from 8.3 to 10 microns, see Figure 3. Since there is only one light the problem associated with the multimode fiber does not exist and by this we can have a higher transmission rate and also it can be used for longer distance. To utilize the fiber a Wave-Division-Multiplex (WDM) is used as it will be described later.

14. This type of fiber has been improved over years and that result in three types of single mode fiber. The first is Non Dispersion-Shifted Fiber (NDSF) which was used to transmit light with wave length 1310 nm, but some systems use it with a wave length of 1000 nm and this wave length causes dispersion (losing pulse mode) with this type of fibers. The second type is Dispersion-Shifted Fiber (DSF), in this type the dispersion is shifted so that the dispersion at the wave length 1550 nm is zero and in this way we could solve the problem of the first. But system with DWDM (Dense Wavelength Division Multiplexing) found to be nonlinear with this type of fiber. The term Dense Wavelength Division Multiplexing (DWDM) came from the tremendously increase in use of WDM. The third type is Non Zero-Dispersion-Shifted Fibers (NZ-DSF) which is designed to solve the problems with the previous two.

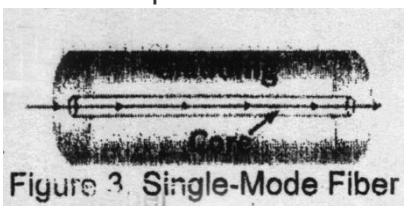


Figure 3. Single-Mode Fiber

Fiber Cables

15. As with copper wires optical fiber need to be protected from the surrounding environment. Grouping fibers into one cable has other advantages as well which are Ease of Handling, Protection, Crush Resistance and Degradation. Fiber cables fall in three basic categories: loose tube cable, tightly buffered fiber and ribbon cables.

Loose Tube Cable

16. In loose tube design a coated fiber is contained in a tube, with inner diameter must larger than the fiber diameter. To make the fiber move freely inside the tube, it is installed a loose helix and also by this the fiber can be protected from the stresses applied to the cable in installation or service, including effects of changing temperature. Loose tubes can be used without any filling. However, if they are to be used outdoors, they are normally filled with a jelly like material. The gel acts as a buffer, keeping out moisture and letting the fiber move in the tube, Figure 4.

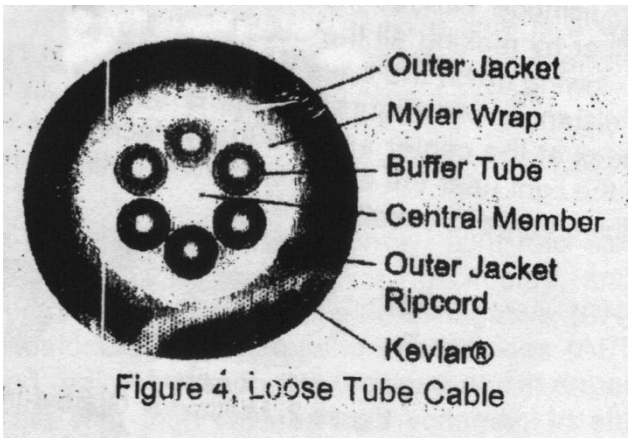


Figure 4, Loose Tube Cable

Ribbon Cables

17. Ribbon Cables have small variation form the tight buffer cables. In Ribbon cable design, the fiber is coated as the case in tight buffer cable. Then a group of the coated fibers is arranged in parallel and then all the fibers are coated with plastic to form a multi fiber ribbon. This differs from the tight buffered cables in that one plastic layer encases many parallel fibers, see Figure 6. Typical ribbons contain 5 to 12 fibers. Up to 12 ribbons can be stacked together to form the core of a cable. The simple structure makes a ribbon cable easy to splice in the field; a single splice can connect multiple fibers. Multi fibers connectors can also be installed readily.

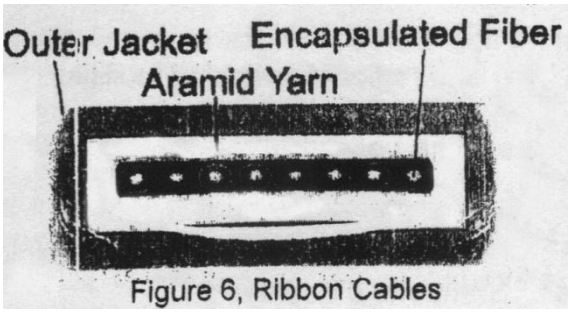


Figure 6, Ribbon Cables

Wave Division Multiplexing (WDM)

18. With WDM it is possible to send multiple optical signals from deferent source at the same time on one optical fiber. The data stream from each source is assigned an optical wavelength. The multiplexer modulates each data steam from each source. After the modulation process the resulting optical signal generated for each source data stream is placed on its assigned wavelength. The resulted signals are simultaneously sent through the fiber.

19. At the user end the multiplexer receives a composite signal. It separates the signal into the original signals according to their different wavelengths by using prisms. These signals are further demodulated. The resulting separated data streams are then provided to the respective users.

20. The difficult part of the multiplexing process is at the receiver side (demultiplexing). The designers have to put into their considerations for the crosstalk and channel separation in the demultiplexing. The crosstalk specification expresses how well the demultiplexer maintains port-to-port separation. That is each channel should appear only at its intended port. Channel separation describes ability for the demultiplexer to distinguish different wavelengths. In most demultiplexer, the wavelengths must be widely separated allowing light to travel in either direction without the penalty found in splitters.

Some Application

21. Due to the advantages of fiber optic over the traditional connectivity.... networks are being changed to the new technology of fiber optic. Here is some application use fiber optic for the communication:

a. Long Haul telecommunication systems on land and at sea to carry the simultaneous telephone calls (or other signals) over long distances. These in ocean spanning submarine cables and national backbone networks for telephone and computer data transmission.

b. Interoffice trunks that carry many telephone conversations simultaneous between local and regional switching facilities.

c. Connections between the telephone N/W and antennas for mobile telephone service.

d. Links among computers and high resolution video-terminals used for the purposes as computer a ded design.

e. Transmission of signals within ships and aircraft.

f. Local Area Networks operating at high speeds or over large areas backbone systems connecting slower local area Networks.

g. High speed interconnections between computer and peripherals device between computers, or even within segments of single large.

TASK-10

ARMAMENT

EXPLOSIVE REGULATIONS & ADMINISTRATION

Introduction

1. Stores containing explosives (includes certain chemical compositions) require special precautions in handling and storing. The aim is not only to preserve their serviceability but also to provide a reasonable degree of safety to personnel handling them and to other persons and property. It is, therefore, always to be borne in mind that the regulations deal with the stores which are inherently dangerous.

All persons employed in the custody and handling of explosives is to understand the basic principles involved and thus be able to apply the regulations in the right spirit.

Definition of Terms

2. To avoid misunderstanding or misinterpretation where the precise meaning of a word or phrase is important, the following definitions are to be used in so far as the regulations are concerned:

a. **Ammunition.** It is a enclosed explosive substance designed to produce an explosive effect.

b. **Ammunition Supply Depot.** It is a unit at which large number of explosives is stored and maintained. Normally, it contains an explosives area, explosive laboratories, a destruction ground, transport and other facilities, attendant offices and other buildings required for the storage, servicing and movement of explosives

c. **Black List.** It is a record of unsafe and inefficient explosives and dangerous goods and the authority for their disposal.

d. **Blind.** It is a prepared explosives store which though initiated has failed to function.

e. **Category.** It is a division of explosives according to the risk they present when initiated in storage. The categories in use are as follows:

(1) **Chemical Ammunition.** Explosives containing toxic materials, with or without other explosives which have a toxic risk, with or without slight explosion risk.

(2) **Category 'X'** . Explosives which have a fire or a slight explosion risk or both, the effect of which will be local.

(3) **Category 'Y'.** Explosives which have mass fire risk or a moderate explosion risk but not the risk of mass explosion.

(4) **Category 'Z'.** Explosives which have mass explosion risk with serious missile effect.

(5) **Category 'ZZ'.** Explosive which have mass explosion risk and a minor missile effect.

f. **Charge Weight Ratio (CWR)** The ratio (expressed a percentage) of the weight of explosive filling in an explosive or package of explosives to the gross weight.

g. **Classification.** It is a division of explosives according to their general characteristics in storage and transport, commercial explosives are classified by the home office into classes and divisions; service explosives are classified into groups.

h. **Danger Building** It is a building where dump or underground chamber authorised for use by a competent authority, in which explosives are dealt with in any way or are stores.

j. **Dangerous Goods.** Certain types of stores, analogous to explosives and similarly used, which do not contain explosives.

k. **Destruction Ground or Site** It is an area where explosives are disposed off by burning or detonation.

l. **Detonation** The very rapid chemical change of a mass of explosives producing large amounts of heat and gases, accompanied by very high pressure and an intense local shattering effect.

m. **Detonator** A case or capsule containing an explosive substance capable of being easily initiated.

n. **Dump** A defined area for the storage of explosives.

p. **Explosives** All substances used to produce an explosive incendiary or pyrotechnic effect.

q. **Explosion** A phenomenon similar to detonation, but which proceeds less rapidly through the explosive & is not accompanied by intense local shattering effect.

r. **Explosives Laboratory** A danger building or area authorised for use by a competent authority wherein operations in connection with the servicing and inspection of explosives is carried out.

s. **Explosive Store House** A danger building or portion of a building authorised for use by a competent authority in which explosives are stored, and which is not under "clean conditions".

t. **Hang Fire** The unintentional delay in the initiation of a propelling charge.

u. **Isolation** The storage of explosives in a dangerous or possibly dangerous condition in separate accommodation away from all other explosives.

v. **Magazine.** A danger building authorised for use by a competent authority and maintained under "clean conditions in which explosives liable to function by spark or friction are stored.

w. **Misfire.** A failure to fire where the defect is in the initiating mechanism, in the initiator or in the propelling charge.

x. **Net Explosive Quantity (NEQ).** The weight or explosive substance excluding that in safety class ammunition, in explosive items or in a danger building.

y. **Propellant** A substance, which by controlled burning, provides the gas pressure required to accelerate a projectile.

z. **Pyrotechnic** An explosive store, generally containing combustible materials for the production of fire, light, smoke or sound.

aa. **Ready Use Explosive Store house** A danger building authorised for use by a competent authority conveniently sited for the storage of explosives for immediate issue or use.

ab. **Red Card (BAF Form-2884)** A Form to indicate suspect or obsolete explosives and associated non- explosive stores.

ac. **Segregation** The storage apart but not necessarily in separate accommodation of explosives.

ad. **Traverse** A natural or artificial barrier the purpose of which is to localize the effects of an explosion within the barrier and to minimize the effects of an external explosion.

Safeguarding of Explosives Area and danger Buildings

3. In view of the risks attached to explosives and the possibility of their misuse, protective measures are to be taken as under to safeguard them at all times.

a. **Protective Measures** Provision is to be made against the risk of fire, explosion or blast including the risk of such hazards by lightning, attack from the air or ground, theft and sabotage.

b. **Fire** Adequate fire fighting equipment is to be provided and personnel are to be trained in its prompt use to combat outbreaks of fire in explosive areas. Liaison with local fire fighting is to be maintained.

c. **Air Attack.** The possibility of attack from the air is always to be considered when sitting explosives storage.

d. **Ground Attack** Defence measures are the responsibility of the appropriate local authority.

e. **Lightning Protection.** All danger buildings are to be provided with lightning protection system.

f. **Theft and Sabotage** To prevent unauthorised approach into the explosives area and to safeguard against loss by theft or sabotage and it is to be enclosed by a security fence as prescribed by 3086 (RAF Manual Security). The fence is to be sited at not less than 50m from any danger building.

g. **Safeguarding**. All doors in normal use for entrance to explosives areas and danger buildings are to be fitted with mortise locks. Gates leading to explosives areas are to be kept locked at all times when not in actual use; sentries are to be posted during the time the gates are not secured.

Quantity Distances

4. A danger building presents a risk of explosion or fire in adjacent to danger buildings, damage to property or injury to individuals. Buildings for explosives are, therefore, to be sited sufficiently clear of other danger buildings, main roads, railways, navigable waterways, dwelling or other placed of frequent persons to ensure minimum risk to life and property access of a fire or explosion occurrence.

a. **Kinds of Quantity Distances** There are three kinds of quantity distances from, such as:

(1) **Inside Quantity Distance** This is a clearance to be observed between store houses and magazines.

(2) **Special Inside Quantity Distance** This is a clearance to be observed from magazines and store houses to laboratories, missile preparation sheds and other workshops within the explosives area.

(3) **Outside Quantity Distance** It refers to the clearance between a danger buildings and other places used buy the general public and the service outside the explosives area.

Factors Governing Quantity Distances

5. The quantity distances necessary for a danger building to achieve the required degree of safety depend upon the following factors:

a. The net explosive quantity of the building.
b. The quantity distance category of the explosives.
c. The charge weight ratio of the explosives.
d. With certain categories, whether the building is effectively traversed.

Traverses

6. Traverses may take any of the following forms:

a. Double slope type.
b. Vertical face type.
c. Wall type.
d. Bunker building type.
e. Partial vertical face type.
f. Steep double slope type.

Classification of Explosives by Groups with Characteristics Storage Conditions and Category.

7. The following list gives a general idea of the explosives storage, applicable to the BAF to be found in the various groups:

Group	Characteristics	Storage conditions	Category
1.	Explosives bearing a fire and explosion risk and relatively sensitive to spark or friction. Not containing a means of ignition eg Gun cotton primer dry 1 oz.	Magazine	ZZ
2.	Explosives liable to decomposition bearing an explosion risk; not containing their own means of ignition eg; Nobles 808.	Magazine but may be placed in explosive store house.	
3.	Explosives liable to decomposition, bearing a fire risk not containing their own means of ignition. No BAF store has been classified in this group.		
4.	Stable explosives bearing a fire or explosion risk, not containing their own means of ignition eg; Bomb ML Mortar 3" smoke	Magazine but may be placed in explosive store house.	
5.	Unboxed shells or bombs filled, high explosives gun powder or star compositions filled or plugged or fuzed eg Bomb a/c HE and Flashes photographic.	Explosive Store House	
6.	Boxed ammunition, containing high explosive, gun powder and propellants only with or store house without its own means of ignition.	Explosive Store House	X Y Z
7.	High Capacity Ammunition, filled high explosive plugged, with or without components in the package. Bomb a/c HE.	Explosives store house	Z
7A.	High Capacity Ammunition filled high explosives; contains its own means of ignition.	No applicable to BAF	
8.	Mortar and Rocket ammunition and grenades, filled with high explosive or gun powder and high explosive charges with or without propellants and components in the packages.	Explosive store house	ZZ X Z
9.	Pyrotechnics	Explosive store house	X
10.	Detonators and initiatory compositions.	Explosive store house	Z
11.	Incendiary and smoke ammunition not containing phosphates, white phosphorus, inflammable liquid or gel with or without components in the packages.	Explosive store house	Y X
12.	Ammunition containing phosphates or white phosphorus, with or without components in the packages.	Explosive store house	X
13.	Chemical ammunition, with or without, components in the packages.	Explosive store house	Chem
14.	Applicable only to Naval ships.		
15.	No BAF Stores are classified in this group.		

Administration of Explosive Areas and Danger Buildings

General Regulations Poster No 16

8. Every person who is required to enter an explosives area must be conversant with the regulations detailed on poster No 16. The poster is to be displayed at the entrance of the every explosives area and every danger building. Infringement of the regulations by any person subject to the Air Force Act will result normally in trial by Court Martial. Ignorance of the regulations is not accepted as a mitigating circumstances.

Storage of Explosives Above Ground Poster No 72

9. In addition to poster No 16 a copy of poster No 72 is to be displayed in every danger building above ground. This poster gives details of the regulations for the storage of explosives above ground.

Storage of Explosives under Ground Poster No 73

10. In addition to poster No 16 a copy of poster No 73 is to be displayed at each entrance to an underground storage area. This poster gives details of the regulations peculiar to the storage of explosives underground.

Articles in Use List F-1008

11. This Form which is to be displayed in each laboratory or in each room of a laboratory, lists of each item of moveable equipment normally kept there. Any special tools or appliances required for a specific operation are to be detailed on the relevant BAF Form 1004. Without prior sanction of the officer in charge no one is to take nay chemical or explosives substances, or any tool or appliance, into a laboratory except as authorised on the relevant Forms 1008 and 1004.

Men and Explosives Limits Form 1004

12. The purpose of Form 1004 is to regulate, within the maximum hot quantity of explosives permitted in each building by Form 1003A the amount of explosives which may be held in each room in relation to its size, the number of persons employed therein, the nature of the work to be done and to stipulate the special tools or gauges required for the work. The form is to be prepared in duplicate, by or under the direction of the officer in charge. It is to be displayed in each room.

Rules for Entering or Leaving a Clean Area Poster No 49

13. A copy of this poster is to be displayed explosives conspicuously at each entrance to every magazine and laboratory. The poster depicts a typical layout of the entrance to a clean area.

Danger Building Log Book Form 4306

14. Each explosives area and all buildings where explosives are held are to be inspected each week by armament engineering or supply XF officer. The inspection including infringement of regulations damage to buildings etc and the appropriate action taken are to be recorded in the danger building Log Book. The log book is to be brought to the notice of Commanding Officer in each month and other such occasions whom action is required.

Control of Vegetation and Livestock

15. Natural growth of vegetation is to be controlled as follows:

a. Within 2 meters of a danger building no growth of vegetation is permitted.

b. Within 9 meters of a danger building grass is to be kept short.

c. Any cut vegetations is to be removed immediately after cutting. Livestock may enter explosives areas for the purpose of transport and in special circumstances for grazing.

Ventilation of Danger Building

16. Certain explosives readily absorb moisture from the atmosphere or are liable to deteriorate in extremes of temperature. It is important, therefore, that the interior of danger buildings are kept as dry and temperate as practicable, good ventilation will assist in this. Despite the importance of ventilation the indiscriminate admission of air into certain danger buildings may do more harm than good.

17. The ventilators of above and underground explosive store houses and magazines are normally to be kept open being temporarily closed only as an immediate precaution against the entry of rain, hail etc. During wet weather doors of aboveground buildings are to be opened as infrequently as possible and then only for as long as is really necessary. In general, however, the majority of danger buildings can be freely ventilated.

Inspection of Explosives

18. All explosives held are to be submitted for inspection annually or at shorter intervals, as detailed in AP 1086, Book 6. Units are to submit their stores for inspection on Form 3284 to AIS. After inspection AIS will pass sentence on each explosive. The sentence given to BAF explosives after inspection is denoted on the inspection form by using the following symbols:

a. **Serviceable (Symbol-'▲')** Fit for immediate use for all purposes for which the items are held.

b. **Repairable (Symbol 'R')** Capable of being made serviceable by repair.

c. **Unserviceable (Symbol '+')** Unfit for use and beyond repair; thus fit only for reduction to salvage or disposal by an approved method.

d. **Unclassified (Symbol 'U/C')** Need further inspection before classification as serviceable repairable or unserviceable.

Fire Prevention and Firefighting

19. a. **Local Orders** Local orders are to be prepared and poster in conspicuous position.

b. **Water Supplies** Unless an adequate natural water supply is available, provision is to be made for static supply of water.

c. **Fire Breaks** Fire breaks is to be maintained around each danger buildings.

d. **Fire Alarm System** An efficient fire Alarm System is to be available throughout the danger area. These points are to be visible at all times.

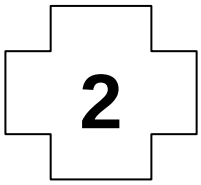
e. **Escape Drill** Personnel employed in danger area are to aware of the position of both normal and emergency exits of danger building in which they work. During a fire fighting practice they are to be given practice of emergency escape from both the normal and emergency exists.

f. **Fire Class Symbol** To facilitate the task of firefighting the appropriate fire class symbol is to be positioned on an adjacent danger building. The fire class symbols are as follows:

(1) **Class 1** Building marked with this symbol contain explosives which must be expected to explode "En-masse", very soon after fire reaches them.

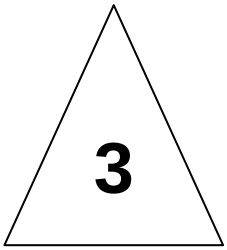
Action Fight in the early stages with the first aid fire fighting equipment provided. If this is unsuccessful abandon the building and concentrate on prevention the fire spreading to the surrounding buildings. Personnel not on essential duties must be evacuated to a safe position.

(2) **Class II** Buildings marked with this symbol contain substances which are readily ignited and burn with great violence without necessarily exploding.



Action Fight in the early stage with first aid fire fighting appliances and equipment provided. If this is unsuccessful abandon the building concentrate on preventing the fire spreading to the surrounding buildings if necessary be drowning their contents.

(3) **Class III** Buildings marked with this symbol contain explosives which may explode "Enmasse" but compared with fire class I explosive may be exposed to fire for sometimes before exploding. There will and fragment hazard.



Action Fight in the early stage with first aid fire fighting equipment provided. If this is unsuccessful abandon the building and concentrate on preventing the fire spreading to the surrounding buildings if necessary by wetting them and drowning their contents. Personnel not required for essential duties are to be evacuated to a safe position.

(4) **Class IV** Buildings marked with this symbol contain explosives which burn fiercely and give off dense smoke within certain instances toxic effects. There is no risk of mass explosion.

Action Fight from the windward side, use plenty of water. Avoid contamination by phosphorus. Use breathing apparatus if available.

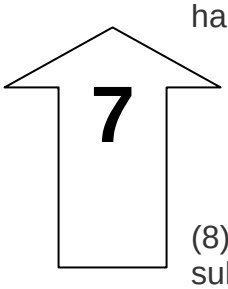
(5) **Class V** Buildings marked with this symbol contain explosives and toxic substances. There is no risk of mass explosion but toxic effect may be serious.

Action Fight from the windward side. Avoid contamination of toxic chemicals. Wear respirators and protective clothing personnel not required to be evacuate to safe position.

(6) **Class VI** Buildings marked with this symbol contain explosives which may be exposed to fire for some time before exploding. The risk of mass explosion is not involved, but small sporadic explosion will occur with increasing frequency as the fire takes hold. There is a fragment hazard but not a serious blast risk.

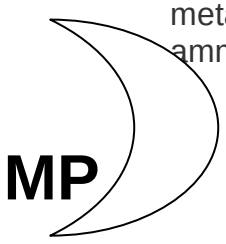
Action Fight in the early stages with first aid fire-fighting equipment provided. If this unsuccessful, continue fighting from behind a suitable cover such as an adjacent earth traverse or a brick building using plenty of water.

(7) **Class VII** Buildings marked with this symbol contain explosives which involve a combination on of highly inflammable and corrosive liquids; which may be exposed to fire for some time before exploding. The risk of mass explosion is not involved but explosion will occur with increasing frequencies as the fire takes hold. There will be a fragment hazard arising from pressure burst but not a serious blast risk.



Action Fight in the early stages with first aid fire fighting equipment, if unsuccessful continue fighting from the suitable cover. Use acid proof clothing and breathing apparatus.

(8) **Class 'MP'** Buildings marked with this symbol contain substances of the non explosive dangerous goods class, containing metallic powders such as magnesium, aluminum or zinc powders either in ammunition or in bulk.



Action Fight with the first aid fire-fighting equipment provided. Burning powdered asbestos or asbestos graphite, care being taken to avoid agitating the burning powder.

Water is not

WATER IS NOT TO BE USED

Defective Explosives

20. **Red Card F-2884** It indicates that the stores to which it refers are "NOT TO BE USED" pending further instruction. Units are responsible for affixing Red Card (Explosives) to all explosive stacks and associated stores when:

a. They have been temporarily banned by Air HQ for issue or use.
b. They are defective or suspected.
c. They are undergoing inspection or are awaiting proof results.
d. They have been certified by ALO inspector as unsafe for use but safe for storage.
e. They are salvaged stores recovered after an accident or trial or they are under experimental stage.

21. **Removal of Red Card** The restrictions imposed by red card are to be lifted only under the following conditions:

a. On receipt of instructions issued by Air HQ.
b. When stocks have been sentenced serviceable by a QAS inspector of explosives.
c. When disposal action has been taken on stocks concerned.

22. **Black Listing of Explosives** Black listing is the procedure whereby a record is maintained of al inefficient of unsafe explosive stores. Black listed stores pending disposal are to be clearly marked and segregated from other explosive stores. Explosives placed on the Black List are disposed off in accordance with Command or Unit instructions as soon as circumstances permit. When a store is black listed a black cross is super-imposed on the Red Cared (F-2884) from corner to corner.

TASK 11

AIRCRAFT ARMAMENT SYSTEM

MIG-29 AC

1. **Introduction.** Mig-29 ac is a single seated front line fighter, light bomber, intended for interception, maneuvering and non maneuver aerial target, all weather and day night ac. This ac is designed to destroy air and ground target from a medium and close distance. This ac is equipped with one GSH-301 single barrel ac gun. Caliber of the gun is 30 mm. The gun is located in the compartment of left side leading edge extension. The ammunition box is installed in the special compartment to the left of the ac line of symmetry. The gun is fired by electrically and remotely controlled.

2. **Armt System of MIG-29 ac.** Armt capability of MIG-29 ac are shown in Anx A. However, the ac has fol armt system:

a. Gunnery System
b. Rocketing System
c. Bombing System
d. Missile System
e. Jamming Control System
f. Ejection Seat System and
g. Fire Extinguishing System

3. **Technical Data of Aircraft Gun GSH-301 of Mig-29 ac**

a.	Caliber	: 30mm
b.	Loading Capacity	: 150 Rds
c.	Rate of fire	: 1500 to 1800 rounds per minute
d.	Muzzle velocity	: (860+15) m/s
e.	Weight of the gun	: 50 kg
f.	Effective Range	: 1200 to 1800 mtr
g.	Recoil force of gun.	: 6000 Kg
h.	Life of the gun	: 3000 Rds with two spare barrel
j.	Operating voltage	: 27 v + 10%
k.	Barrel life	: 1000 shots
l.	Length	: 1978
m.	Width	: 153.5 mm
n.	Height	: 185mm

F-7MB ac

4. **Introduction:** F-7MB aircraft is a single seated and light weight supersonic fighter with good air to air dog fighting and air to ground attacking ability. The aircraft has five external suspension stations and one fuselage belly suspension station. It can carry one 500 ltr or 800 ltr drop tank. (That is the 480 ltr or 720 ltr in capacity). It can carry two missiles of PL-7 or two 50-500kg of bombs or two HF-5A (or HF-7B) rocket launchers or 50-1000 kg bombs. These five suspension stations may form many different weapon suspension configurations.

5. **Armt System of F-7MB ac.** Armt capability of F-7MB ac are shown in Anx A. However, the ac has fol armt system:

a. Gunnery System

b. Rocketing System

c. Bombing System

d. Missile System

e. Smoke generation System

f. Ejection Seat System

g. Fire Extinguishing System

h. Tow target System

6. **AC Gun.** The 30mm aircraft gun M1 (code named 30-1 gun) is provided for fighter, and also for attacker or bomber. Ammunition used by 30-1 gun is 30mm high explosive incendiary cartridge M1 and 30mm armour-piercing explosives cartridge M1. The gun housing is attached to the mounts. The fore mount is strength member and the aft mount, a support. The 30-1 gun is charged and extracted by compressed air system and firing is controlled by direct current. In the electric trigger are installed two electric sensors: a barrel sensor and a bolt sensor, which are employed to give signal ready for firing.

7. **Main Technical Data of 30-1 Gun**

a	Caliber	: 30mm
b.	Rate of fire (at temperature 2^0 C	: not less than 850 rounds per minute
c.	Muzzle velocity of projectile	: 780 10m/sec
d.	Weight of gun	: 66.5 1 kg.
e.	Length of gun	: 2,153 mm
f.	Compressed air pressure for pneumatic charge	: 38-60 kg/cm
g.	Service life of gun (incl application individual set of spare parts)	: 2,000 rounds.
h.	Recoil force acted on the rigid mount (with rigidity being 600 kg/mm)	: not more than

F-7BG AC

8. **Introduction.** F-7BG ac is a light, Mech 2.0, single seat (7-), single engine supersonic fighter ac. The F-7BG aircraft adopted double delta wings with leading & trailing edge maneuvering flaps whose deflection angle is automatically regulated with the change of flying angle of attack, speed and altitude. The F-7BG aircraft with excellent combat effectiveness in particular, at low and medium altitudes it has five fired points. The operational life of the aircraft is 2400 flying hrs at 24 years with two overhauls under operation conditions.

9. **Armt System of F-7BG ac:** Armt capability of F-7BG ac are shown in Anx-A. However, the ac has fol armt system:

a. Gunnery System
b. Rocketry System
c. Bombing System
d. Missile System (2xPL-9C air to air missile)
e. Chaff and Flare Dispensing System
f. Smoke System
g. Banner System
h. Fire extinguishing System
j. Seat Ejection System (TY-6c 0-0)
k. Store management control display system (SMS)

A-5IIIA AC

10. **Introduction** The aircraft is a single seat. Supersonic attack aircraft powered by air support to the ground forces by penetrating through the enemy defence line at a high speed either at law or at very low altitude, striking at various enemy ground targets. The air to ground attack mode is either level bombing or diving bombing. Further more, the ac can conduct air-to-air fight against enemy aircraft by means of airborne missile and guns.

11. **Armt System of A-5IIIA ac** Armt capability of A-5IIIA ac are shown in Anx A. However, the ac has fol armt system:

a. Gunnery System
b. Rocketry System
c. Bombing System
d. Missile System
e. Smoke System
g. Fire extinguishing System
j. Seat Ejection System

12. **AC Gun** The ac is equipped with two type 23-2k ac machine guns. Constituting a parallel fire net during attacking. It can fire type II 23mm armour piercing incendiary or high explosive incendiary aircraft ammunition to destroy air or ground targets with in the range of 2000m

13. **Main Technical Data of 23-2K Gun**

a.	Calilbre	: 23 mm
b.	Rate of fire at normal temperature	: not less than 1150 rds/min
c.	Muzzle Velocity	: 705 + 10 m/sce
d.	Weight (including shock absorber)	: 47.+ 1kg
e.	Service life (incl the complete set of spare parts .	: 6000 rds
f.	Pneumatic charging pressure	: 40 to 70 kg/cm2
g.	Lenght (with 1-8k flash eliminator)	: 1603
h.	Lenght (without 1-8k flash eliminator)	: 1467 mm
j.	Width	: 158.5 mm
k.	Heigh	: 174.5 mm

L-39 ZA AC

14. **Introduction:** The L-39 ZA ac is modification of jet trainer L-39. It is determined for the training of pilots in the subsonic air speed envelop. The characteristics of the ac enable the elementary training as well as advance training including aerobatics, fight under bad weather conditions by day and night in case of necessity even in combat flights for destroying slow air targets and targets on the ground. The aircraft engine is a buy pass air flow jet engine with two shafts of the A1-25 TL type.

15. **Armt System of L-39ZA ac.** Armt capability of L-39ZA ac are shown in Anx A. However, the ac has fol armt system:

a. Gunnery System

b. Rocketry System

c. Bombing System

d. Missile System

e. Fire extinguishing System

f. Seat Ejection System

16. **AC Gun** The L-39 ZA ac equipped with one GS-23 twin barrel gas operated automatic weapon with fixed barrels. The gun is provided with 150 round of ammunition.

17. **Basic Dta of GS-23 Gun:**

a.	Calilbre	: 23 mm
b.	Muzzle Velocity	: 715+15M/S
c.	Mass of the Complete gun	: 49.2+1.5 kg
d.	Length of the Gun	: 1387 mm
e.	Width of the Gun	: 165 mm
f.	Height of the Gun	: 168 mm
g.	Life of the Gun	: 4000 rds
h.	Rate of fire	: 3000 upto 3400 shots/min

MI-17 Helicopter

18. **Introduction** MI-17 hel is a Russian made heavy duty hel. It can carry 24 passengers and 4000 kg of cargo loads.

19. **Armt System of MI-17 hel** Armt capability of MI-17 hel are shown in Anx A. However, the ac has fol armt system:

a. Gunnery system

b. Rocketing system

c. Bombing system

d. Pyrotechnique system

e. Hoisting system

f. Under sling system

g. Machine gun armt system

h. Ambulance system

20. **Gun.** The MI-17 hel is furnished with the УПК-23-250 unified gun containers with the GSH-23L guns for ground and aerial firing.

21. **Technical Data of Gun GSH-23L:**

a.	Calilbre	: 23 mm
b.	Muzzle Velocity	: 715+15M/S
c.	Mass of the Complete gun	: 50.3+1.5 kg
d.	Length of the Gun	: 1537 mm
e.	Width of the Gun	: 165 mm
f.	Height of the Gun	: 168 mm
g.	Recoil force:	: 2900 kg
h.	Length of the barrel	: 1000mm
j.	Rate of fire at normal conditions	: 3000 upto 3400 shots/min

TASK - 12

BASIC TYPES OF AIRCRAFT AMMUNITIONS, BOMBS, ROCKETS & MISSILES

Aircraft Ammunitions

1. Aircraft ammunitions are used for destroying various types of targets, both in air and on ground. The targets may be anything from human beings to armored tanks and vehicles. For this reason there are various types of ammunitions for attacking each type of target, some of the more general type of aircraft ammunitions are described below:

a. **HEI** High Explosive Incendiary (HEI) cartridge is used to destroy non armoured targets. It contains high explosive buster charge which when exploding on impact produces fragments which can destroy the target while the heat of explosion can cause the target to burn. The 30mm HEI for F-6 A/C and 23mm HEI (oz) for Mig-21 A/C are of this type.

b. **HEIT** High Explosive Incendiary Tracer (HETT) cartridge is the same as HEI cartridge except that it contains a tracer component in it which help in showing the trajectory of the bullet visually so that the pilot may be able to correct any error in the gunnery.

c. **HEAP** High Explosive Armour Piercing (HEAP) cartridge is used to destroy armoured targets in air and on ground.; The outer cover of the warhead of this type of cartridge is both thick and hard which is an armour piercing rigid body and charged with buster charge. This cartridge is also called armour Piercing Incendiary (API) as the explosive can also set fire to inflammable material inside the target.

d. Ball cartridge, which has an inert warhead, is used mainly for training purposes and for firing on ground for ground testing or "Hot Harmonizing" the a/c guns.

Aircraft Bombs

2. Aircraft bombs are grouped into categories and classes, eg, high explosive, incendiary and practice bombs. The high explosive category which forms the largest group is divided into a series of classes according to the nature of function for which they were designed. Each class then subdivided into separate series of bombs by weight.

3. **High Explosive Bombs.** This category of aircraft bomb from the largest group, ranging from the small 20 1b fragmentation bomb to the large 22000 1b medium capacity bomb. Each class of the group may be summarized as follows :-

a. **General Purpose (GP) bombs.** The general purpose aircraft bomb is now in the obsolescent stage, being replaced by the medium capacity bomb for all general bombardment purposes. The bomb body is streamlined with thick walls and has a charge/weight ratio, of 33 per cent approximately. Some Marks of this class of bomb provide for nose and tail fuzing, others for tail fuzing only. Suspension is by means of a suspension lug screwed to the body and provision is made for fitting a metal tail unit.

b. **Armour Piercing (AP) Bombs**. The class of bomb is designed to penetrate heavily armoured targets without breaking up on impact. To meet this requirement, it is manufactured with a sharp pointed solid steel nose and thick walls. The charge/weight ratio is 10 per cent approximately and the normal filling is shellite this explosive composition being very insensitive to shock and friction eliminates the possibility of premature detonation on impact, due to the rapid acceleration that occurs during penetration of the target. Armour piercing bombs are tail fuzed with a pistol/detonator combination and their tail units incorporates and arming mechanism.

c. **Medium Capacity (MC) bombs.** The medium capacity bomb, which, for all purposes, replaces the GP bomb, is used for general bombardment, but certain marks of the class have been specially designed for deep penetration. The body is of cast, forged or prefabricated steel and the thickness of the walls varies. The charge/weight ratio over the whole range is 50 per cent approximately.

d. **High Capacity (HC) bombs.** This class of high explosive bomb is used for general bombardment purposes where maximum blast effect is required. The bomb is cylindrical in shape and comparatively thin. A domed nose plate accommodates three adapters to receive the exploder container and a nose attachment assists to stabilize the bomb in flight. The charge/weight ration is 75 per cent approximately and nose fuzing only is employed.

e. **Cluster Bombs.** This type of bomb is actually a metallic container with a large number of small bomb lets inside. On being released the container or the "Mother Bomb" open up in the air and releases a cluster of bomb lets or "chi stores". The bomb lets are of anti-personnel and anti-tank type.

f. **Fragmentation (F) Bombs.** It is a high explosive bomb whose body is made in such a way as to break into small fragments of pieces on explosion which then have anti-personnel and anti vehicle effect. The Chinese 100 kg fragmentation bomb is of this type.

g. **Incendiary Bombs.** There are two types of incendiary bombs eg one having solid filling like termite and magnesium the other having liquid filling like gelatinized petrol also called the Napalm bomb. The main purpose of this type of bomb is to set the target on fire.

h. **Practice Bombs.** This class of aircraft bomb is used for day and night practice bombing against land and water borne targets. Their function is to pinpoint the place of impact by means of either a cloud of white smoke, or a brilliant white flash, or a cloud of white smoke and a brilliant white flash, or a flaming mass.

Aircraft Rocket

4. **57-1 Aircraft Rocket Chinese.** Type 57-1mm aircraft rocket is used to attack non-armored targets both in air and on the ground.

a. **Main Data**

(1)	Total length with fuze	: 915mm
(2)	Total weight of rocket	: 3.99 Kg.
(3)	Resistance value of an electric igniter squib	: 2.5-4.5 ohm
(4)	Effective range	: 2000m
(5)	Maximum range	: 7000m
(6)	Height for use	: 20,000m

5. **Rocket 240 mm.** Rkts are used only against air to ground target. .

Main Technical Data

a.	Caliber	: 240mm
b.	Wt of the rkt	: 235+3kg
c.	Effective range	: 1.6 to 2.5 km
d.	Amount of fragmentation	: 4000 pcs
e.	Burning time of rkt motor	: 1.1sec
f.	Type of fuze	: B-24A
g.	Wt of the warhead	: 123kg

6. **Rocket 80mm.** It is designed for destruction enemies targets. It is also use only against Air to ground armored target.

Technical Data

a.	Caliber	: 80mm
b.	Wt of the rkt	: 11.3 kg
c.	Effective range	: 0.3 to 2.3 km
d.	Amount of fragmentation	: 400 pcs
e.	Burning time of rkt motor	: 5-1.9 sec
f.	Type of fuze	: B-5KII
g.	Wt of the warhead	: 3.6kg
h.	Rkt speed	: 1000-1200 Rpm

7. **Rocket 90mm.** It is a un-guided rockets used for attacking air to ground targets such as airfield, artillery position, firing point, ground facilities, infantry vehicles armoured personnel carriers etc.

Technical Data

a.	Caliber	: 90mm
b.	Wt of the rkt	: 17.1+0.3kg
c.	Max launching range on the ground (pitch angle 45)	: 9896m
d.	Min launching range on the ground (pitch angle 10)	: 3891m
e.	Weight of combat portion	: 7.881 kg
f.	Fuse weight	: 0.324 kg
g.	Overall length (without fuse)	: 1200-1208mm

Missiles

8. **R-27 RI Missile.** This missile can be carried only in the 1st and 2nd station of Mig-29 ac.

9. **Main Technical Data** **R-27 RI**

a.	Weight	: 253 Kg
b.	Diameter	: 230mm
c.	Weight of warhead	: 39 kg
d.	Weight of solid propellant (Rkt motor)	: 95 kg
e.	Thrust of Rkt motor	: 6000 Kg
f.	Time or guided flt (control flt)	: 60 Sec (1 minuet)
g.	Allowed "G" load	: 22 "G"
h.	Max launching altitude	: 27 Km
j.	Min altitude of combat employment	: 0.02 Km (20m)
k.	Max launching range	: 90 Km
l.	Min launching range	: 500 m

10. R-73E Missile

Main Technical Data

a.	Weight	: 105 kg
b.	Diameter	: 17cm
c.	Length from homing head to tail	: 2.9m
d.	Weight of warhead	: 7.4kg
e.	Max launching range	: 30km
f.	Min launching range	: 3km
g.	Max speed of the target.	: 2500kph
h.	Type of warhead fragmentation	: radial

11. **PL-7 Missile.** The PL-7 missile is of the air to-air homing missile, mainly intended for clear- weather (both day and night) close- range combat.

Main Technical Data

a.	Total weight	: 90 Kg.
b.	Warhead weight	: 12 Kg.
c.	Damage effect distance; approximately	: 10m
d.	Launch distance: minimum approximately	: 500m
e.	Operational altitude	: 15 km.
f.	Speed increase over launch aircraft	: 500 to 600 m/s

12. **PL-9C Missile.** The PL-9C missile is of the air to-air IR homing missile.

Main Technical Data

a.	Total weight	: 121 Kg.
b.	Warhead weight	: 9.88 Kg.
c.	Diameter	: 160 mm
d.	Length	: 2992 mm
e.	Damage effect distance; approximately	: 7-13 m
f.	Launch distance: minimum approximately	: 500m
g.	Operational altitude	: 0-20 km.
h.	Speed increase over launch aircraft	: 500 to 600 m/s
j.	Msl Flight speed	: 3.5 M
k.	Max Allowed "G"	: 40 "G"

TASK-13

ELEMENTARY PRINCIPLES OF MISSILE GUIDANCE

Introduction

1. To deliver a warhead accurately the guidance system must be capable of

   a. Calculating the relative position and/or velocity of the missile and target.

   b. Determining present errors in the missile flight path by comparing the required date with the actual flight path.

   c. Using this comparison to provide inputs to the control system that will man oeuvre the missile to reduce the determined errors. Thus three processes are involved, namely navigation, guidance and control.

2. Here is a close interaction between the guidance system, which is computing the demands, and the control system, which causes the missile to move in accordance with these demands; the process is continuous within a "closed loop" system, as shown in Fig. 1.

Nature of the Target.

3. Since the guidance system must determine a position of velocity relationship between missile and target, an examination of target conditions is a reasonable first step.

4. Probably the most important characteristics of any potential target is whether or not it is stationary. If it is, then a predetermined data system will determine data system will suffice even from a moving launcher. If it is moving, the guidance system employed in the missile will require a continuous flow of information implying a continuous data system.

5. In practice, pre-determined data systems are not used against stationary targets on a direct line of sight since it is usually more convenient to apply a guidance technique which employs some characteristics of the target.

6. To obtain information concerning a target by means of sensors, the methods used are either passive (ie by detecting emanations from the target which are not under the control of the receiving system) or active (ie by using reflection from the target as a result of radiations from a controllable source).

Moving Targets

7. A target can move under water, on the surface of water or land, in the air or in space. Its means of propulsion will produce heat and noise and these two sources plus any radar devices the target uses for navigation or jamming are the most likely sources for passive detection. The use of television cameras to view the target would also come in the category of passive detection.

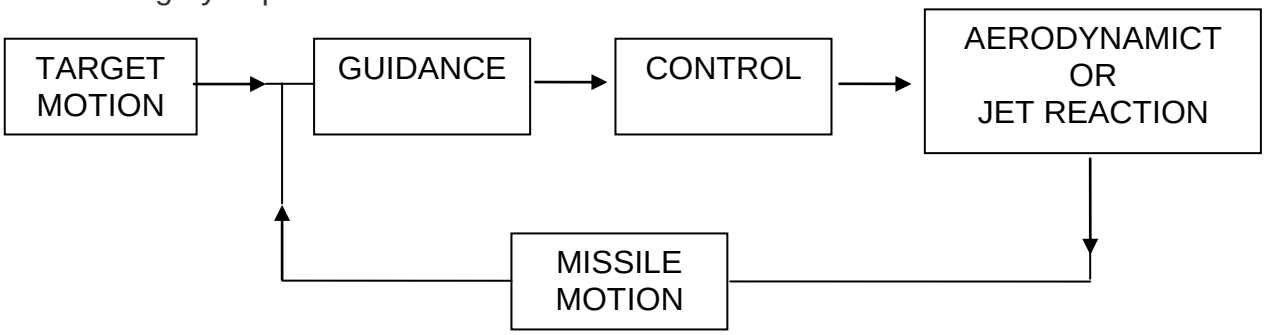


Fig-1

Guidance and Control Loop

8. A missile with its own transmitter receiver would be classed as active, whereas if the missile had only a receiver for detecting reflections from a target caused by transmissions from a friendly transmitter then the missile would be classed as semi active.

9. The presence of target and the use of received information by a guidance system would most probably be determined by:

a. The reception of electromagnetic energy radiated or reflected from the target.

b. The reception of acoustic energy propagated through a fluid medium containing the target, but at present this method is only of significance when referring to underwater targets.

By seeking and finding the direction of maximum intensity of energy emanating from the target, the direction of the target can be ascertained with an accuracy dependent upon the beam width of the receiver.

Stationary Targets

10. Provided that there is information on the location of a stationary target, the guidance should be easier than for a moving target. However, stationary targets may be, for instance, either a city on another continent or a brigade headquarters two fields away and thus the solution to the guidance problem will depend on the range to the target. If the target is at a distance such that a direct line of sight is impossible then the guidance function may take the form of an automatic navigable progress. For instance, a track and distance might be prescribed for a long range missile and the task of guidance then becomes one of detecting errors from this desired track and computing the necessary control demands to remove these errors. Internal guidance is the usual solution to the guidance problem where the target is beyond a direct line of sight range.

Agencies for Achieving Missile Guidance

Electromagnetic Propagation

11. Guidance systems can take advantage of energy radiation in three bands of the electromagnetic (EM) spectrum:

a. Visible light.
b. Infrared radiation.
c. Radio/radar signals.

12. **Visible Light.** Visible light provides and obvious means of setting up a line of sight. The human eye can usually discriminate between two closely spaced targets and between targets and their natural background. Target direction is more easily determined than target range. However, absorption and scattering of visible light by clouds, haze and smoke can severely reduce the effectiveness of a visual system, whether the detector is the human eye or a television camera. Camouflage and very high relative velocity can degrade the value of systems using visible light. Nevertheless, because of the excellences of the human eye as a detection and tracking device and of the brain as a computer", visual systems offer considerable advantage is short range guidance applications.

13. **Infrared Radiation.** All bodies' art temperature above absolute zero radiate infrared energy. At the temperatures associated with engines there is a considerable amounts of radiation emitted in the infrared hand, sufficient to be detected at usable ranges. Being close (in the EM spectrum) to visible light, infrared radiation is subject to similar limitations of absorption and scattering. As with visible light it is difficult to detect the target against the background unless the two are emitting at different wavelengths. Counter measures against infrared detection are difficult to advice.

14. **Radio/Radar.** The radio/radar band of EM propagation provides the most widely used means of obtaining target position and direction. In radar applications, such as the establishing of a line of sight, system are generally limited for range to the optical horizon and subject to some scattering and attenuation ob the atmospheric constituents and by precipitation. A particular advantage of these systems over visual and infrared system is the facility with which range information can be obtained along a single line of sight. Information on target velocity can also be obtained.

Acoustic Systems

15. All moving targets except spacecraft a certain amount of acoustic noise. However, it is only under water that this target characteristic can be exploited by a guided weapon, since the speed of water craft. Sound attenuation in water is only about one tenth thousands of its attenuation in air but this attribute is somewhat of set by the refraction of sound waves be cause of temperature gradients in the water.

Inertial Systems

16. Inertial systems can provide a reference frame of system of axes for navigation and guidance. Py integration of measured accelerations they can give velocity and position information. They are self contained and invulnerable to countermeasure, but in the past their weight, cost and long term inaccuracy have limited their use. Today all operational guided weapon systems incorporate inertial components; the extent of their use may either be limited to one gyroscope or comprise and entire inertial system.

Less Orthodox Agencies

17. The Earth's magnetic and gravitational fields have obvious uses in navigation and guidance. Less obvious phenomena which may be used are gravitational and magnetic anomalies caused by the target's presence; the electrostatic charge on a moving target might also be used. Map matching techniques which compare a radar map obtained by a missile to a previously prepared map can also use.

Summary

18. The brief survey shows that it is convenient to divide guidance systems into continuous data systems and pre determined data systems; this is a classification based on target situation. Continuous data systems are generally associated with moving targets and electromagnetic guidance systems; predetermined data systems are associated with stationary targets and non-electromagnetic guidance systems.

19. In continuous data systems the guidance instructions for the missile may be produced either external to the missile or within the missile. The leads to a natural subdivision of continuous data systems into command and homing guidance respectively. Development of this classification is shown in Fig 2, and in the capters which follow a description is given of each further sub division.

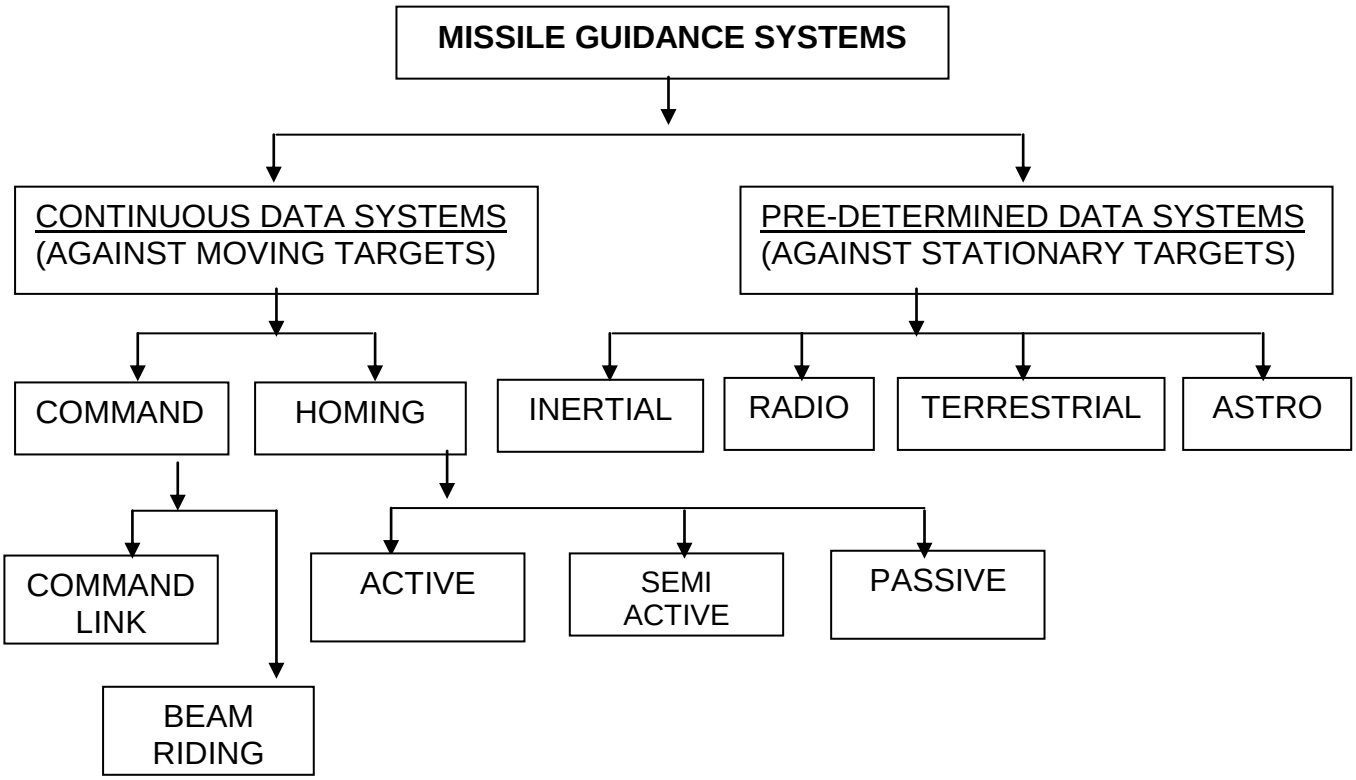


Fig 2, Missile Guidance Systems

COMMAND LINK

Introduction

20. In command link the guidance error is determined at some point outside the missile and converted into the required control demand to be transmitted to the missile. The control demand may be transmitted by electromagnetic radiation or, as often used in antitank systems, electrically by wire. In other words, external to the missile, information is collected about both target and missile and as a result, orders are transmitted to the missile over some form of command link. The guidance unit does not form a part of the missile.

Basic Command Link System

21. In the command link system illustrated in Fig 1 accurate tracking radars continuously measure the three dimensional positions of the both target and missile; the missile course for collision is continuously computed and the control demands are derived and transmitted to the missile over a command link. The link is illustrated here as a separate item but in fact this would not be necessary as the commands are conveyed to the missile modulation of the radar missile tracking beam.

22. The basic command link system is well tried and tested and the guidance/control equipment in the missile is relatively simple, consisting usually of little more than a transponder and a decoder. The guidance function is performed by a computer which if ground based may be at large and complex as desired, but then becomes extensive, bulky and costly. Moreover the highly accurate tracking radars required are not suitable for the initial acquisition of the target so that search radars are also needed. On all these counts, therefore, the basic system would be unsuitable for aircraft installations but simplified forms of command link systems are produced for airborne use.

23. Flexibility in the choice of missile trajectory enables the most suitable interception man oeuvre to be selected. But the basic system handles only one missile at a time thus permitting only a low rate of engagement. However, simultaneous engagements may be achieved by using a tack while scan radar, although this radar is more susceptible to jamming then the highly directional radars of the basic system.

24. Knowledge of the relative position of target and missile becomes less accurate as the range from the ground radar to the target and missile increases.

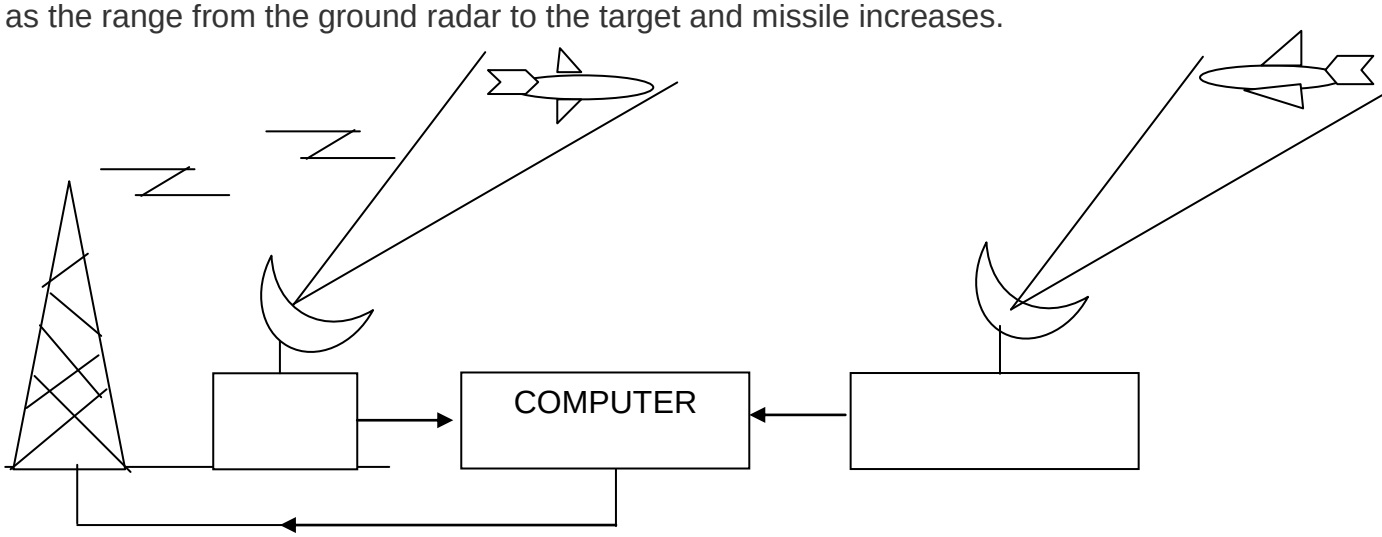


Fig-3 **Command Link**

Line of Sight Command Guidance

25. Line of sight command guidance needs only one tracker and does not require range information; the computer facility is provided by the operator's brain. The operator continuously tracks the target with some form of optical aid and thereby establishes the line of sight. He commands the missile on to this line of the sight to make the missile appear coincident with the target. The steering signals generated by the operator (by moving a small "Joystick") are sent to the missile over a radio link or along fine insulated wires laid out by the missile as it flies towards the target. This method is limited to use in conditions of reasonable visibility but is nevertheless favoured for short range anti tank systems.

BEAM RIDING

Introduction

26. Beam riding is a modified from of line of sight command guidance. The system relies upon the missile automatically centering itself in a radio beam controlled by an operator. Thus the missile flight path may be controlled by moving the beam. In the simplest case the beam is held on the target, either manually or automatically, and the missile will fly along the centre of the beam towards the target.

Tracking the Target

27. Manual tracking of the target has been used, eg in the Fire flash system, where the beam was harmonized to the gyro gun sight. In this short system the pilot tracked the target to hold it within the beam. Amongst the difficulties were those of smoothly tracking the target in bad visibility or at night.

28. For longer ranges automatic tracking of the target by radar is achieved by use of "lock-follow" techniques, of which there are to forms:

a. Static split.

b. Conical scan.

Of these two forms, conical scan is the simpler and is more often used. In conical scan the amplitude of the error signal is proportional to the displacement of the target from scan centre, and some form of communication is required to establish the position of the target.

29. It would be advantageous to use the beam of the auto-follow radar as the beam to guide the missile but in practice several factors make this undesirable and separate beams are used. To ensure the same direction for the two transmissions it is convenient to use the same radar aerial (with electrical synchronization to overcome interference problems).

Missile/Beam References

30. Any displacement of the missile from scan centre will cause the missile receiver output to be modulated at the conical scan frequency; by imposing some form of "clock reference" indication on the guidance beam the angular location of the missile with respect to the beam axes can be established (see Fig 4).

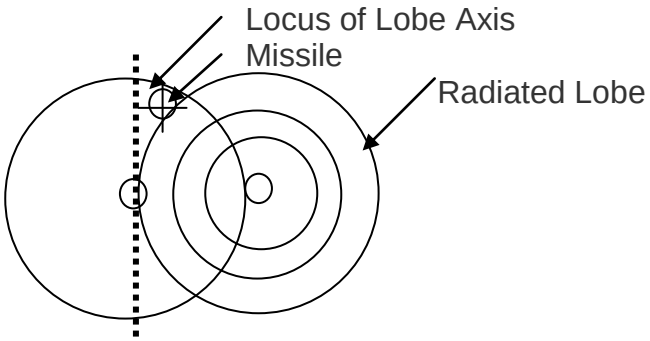


Fig -4. Angular Location of Missile

31. The error signal must be resolved into components along the radar vertical and horizontal exes and the missile establized in the roll plane in such and pitch axes are in alignment with the radar vertical and horizontal axes throughout flight.

32. The radar axis to be defined within the missile for reference purposes, the radar axis reference signal must be transmitted to the missile. It is convenient to use the guiding beam to sent the reference signal and this is done by pulse position-deduction of the beam, ie a form of frequency modulation. Fig.5 shows that the output of the missile receiver is taken to amplitude and frequency modulation detectors, which respectively produce the error and reference signals.

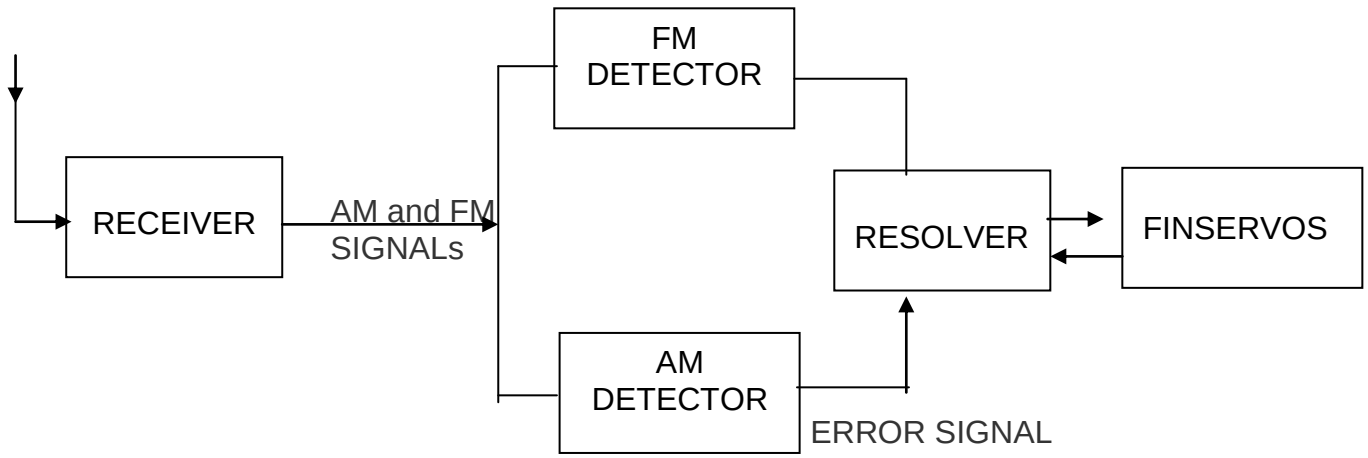


Fig 5 Missile Guidance Receiver

Design Problems

33. The lobe pattern of the rear facing receiver must be broad enough to "see" the radar even when the missile makes a large angle with the beam axis (see Fig.3). The received signal power is an inverse function of range (between radar and missile) and as this variation is undesirable it is necessary to incorporate some means of eliminating it. Generally the receiver attenuation is ----to be a maximum at launch and to decrease the range increases.

34. Since the guidance beam is made as narrow as possible, and because of other factors such as dispersion at launch and wind effects, it may not be possible to lunch the missile into the guidance beam with any degree of certainty. The procedure generally adopted is to add a wide-angle low-accuracy "gathering" beam whose conical beam angle is wide enough to deal with all possible dispersions; the missile finds the centre of this "gathering" beam and then smoothly transfers to the main guidance beam.

35. If a phasing or misalignment error develops between the beam reference axes and the missile axes, the missile tend to approach the beam axis on a spiral track. The misalignment can be due to a number of reasons:

a. Change of radar vertical as the aerial turns away from the launcher bearing in order to follow the target.

b. Errors in the roll datum of the missile, arising from gyro drift.

c. Errors in roll stabilizing the missile to the datum, due to aerodynamic and control imperfections.

36. It is a relatively simple and reliable guidance system, in which a single radar head can be used to provide information for relatively simple missiles. Guidance is partly in and partly outside the missile. "Ripple" salvoes are possible, albeit with certain limitations on the firing interval.

Disadvantages of Beam Riding

37. The trajectory (a pursuit course) shown in Fig 4. is wasteful of propulsive power when the missile is launched from the ground since the missile spends a large proportion of its flight time. at low altitude where aerodynamic loads are greatest, and this proportion increases with interception range. The missile also follows an uneconomical curved track to the point of interception, unless the target is on a course which is radial to the missile launching position. The system is also quite susceptible to jamming of the beam and, as in command link systems, suffers from decreasing accuracy with increasing range. Some of these disadvantages are less pronounced with an air launched missile, but one disadvantage which still applies is only one target can be engaged at a time.

38. Although the system has been described as being relatively simple in terms of equipment used, optimization of the system performance presents a problem, eg while the response of the tracking beam must be such as to permit precise following of the target man oeuvre it must not be so fast as to cause "jittering" of the guidance beam.

Improved Beam Riding Systems

39. In order to reduce the prolonged flight time at low altitude an improved beam riding system can be used in which the missile is directed to climb to a high altitude where the aerodynamic drag effect is considerably reduced. Also it is possible to control the bearing of the transmitter to bring the missile to a calculated interception point and license make the missile fly on a constant bearing instead of a pursuit course. It is of course necessary to provide two independent radars for this purpose and also a suitable computer to solve the cinematic problem. While this system has many features of the command link system it differs in that the missile is still deriving its own steering orders to ride the beam.

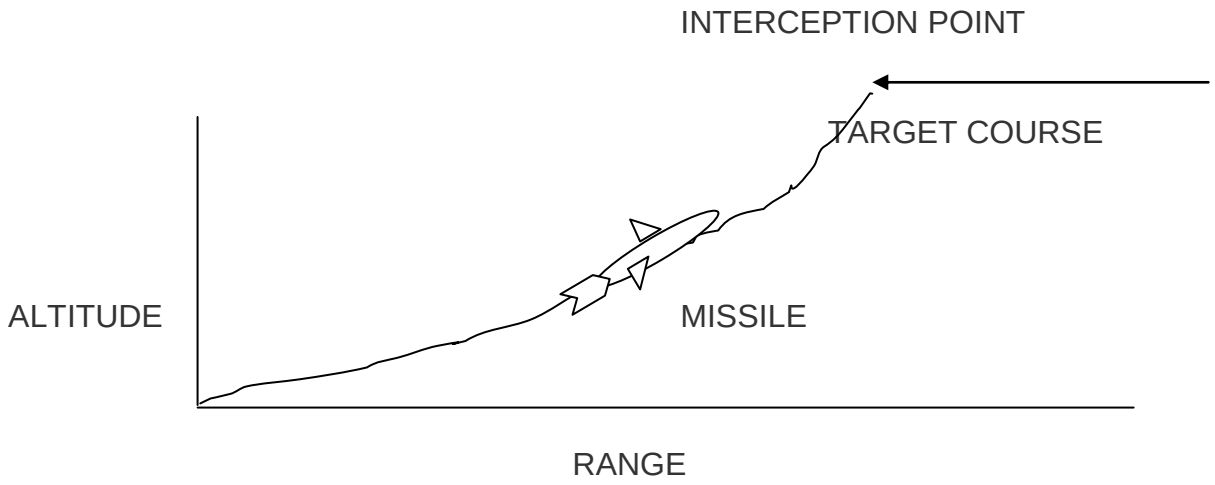


Fig-6, Vertical Pursuit Trajectory of Beam rider

HOMING

Classification

40. A Command guided missile must lock backwards to a guide pint for target information and guidance instructions. The prime feature of "homing" guidance is that the missile looks forward and homes on to its target.

41. A homing missile must therefore establish a line of sight between itself and its target. There are three main methods of establishing this sightline and it is these methods which give rise to three forms of homing; active, semi active and passive.

a. **Active Homing .** The missile transmits some form of energy towards the target and endeavors to receive some reflected portion of this energy to enable it to establish the missile target sightline (Fig-7).

b. **Semi Active Homing .** The target is illuminated energy from a controllable transmitting source not within the missile. The M missile attempts to receive reflections from the target of these signals in order to establish a sightline(Fig-8).

c. **Passive Homing .** The missile carries a receiver which endeavors to detect energy radiated by the target itself and thereby to establish the missile target sightline. As no energy is transmitted by controllable sources, the missile does not advertise its approach to the target (Fig-9).

Note : There is a fourth possible form of homing known as semi passive homing which uses information received about the target from sources not within the target and not under the control of the missile or its supporting service, eg magnetic anomaly, daylight reflections.

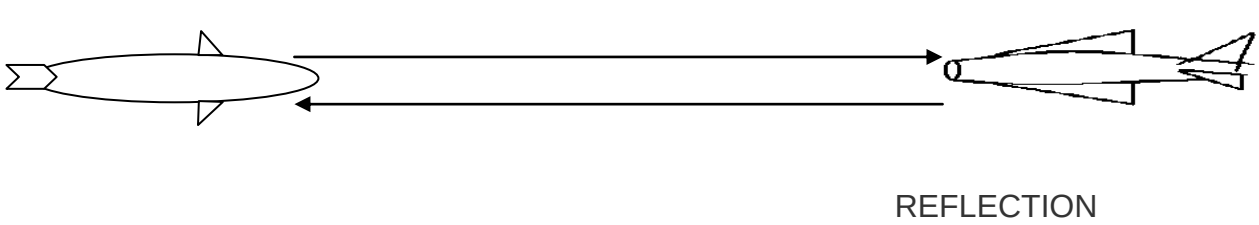


Fig-7, Active Homing

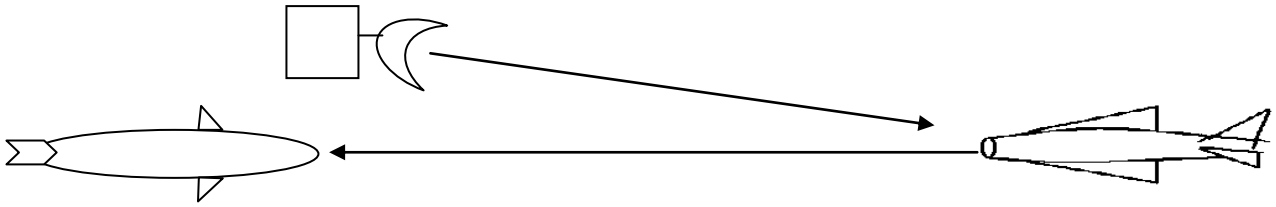


Fig-8, Semi- Active Homing

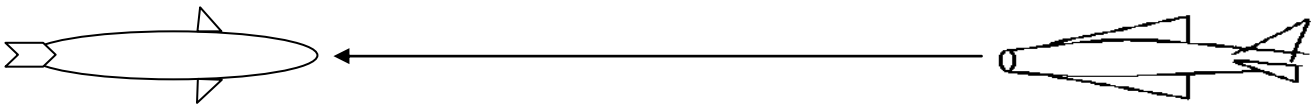


Fig-9, Passive Homing

Proportion Navigation

42. A homing missile guidance head (or "homing head") follows the target movement by means of a lock follow technique and thereby maintains the missile target sightline.

43. In proportional navigation the task of the missile's guidance unit is to measure the rate of turn of this sightline. If the missile is then called upon to turn its flight path in the same direction and at a rate some three or four times the angular rate of turn of the sightline, it can be shown that, in the absence of further target man oeuvre, the missile will eventually take up a course such that the rate of turn to the sightline a course of constant bearing until interception occurs.

44. In proportional navigation the fundamental equation when the movements of the sightline and the missile flight path are in the same geometric plane is:

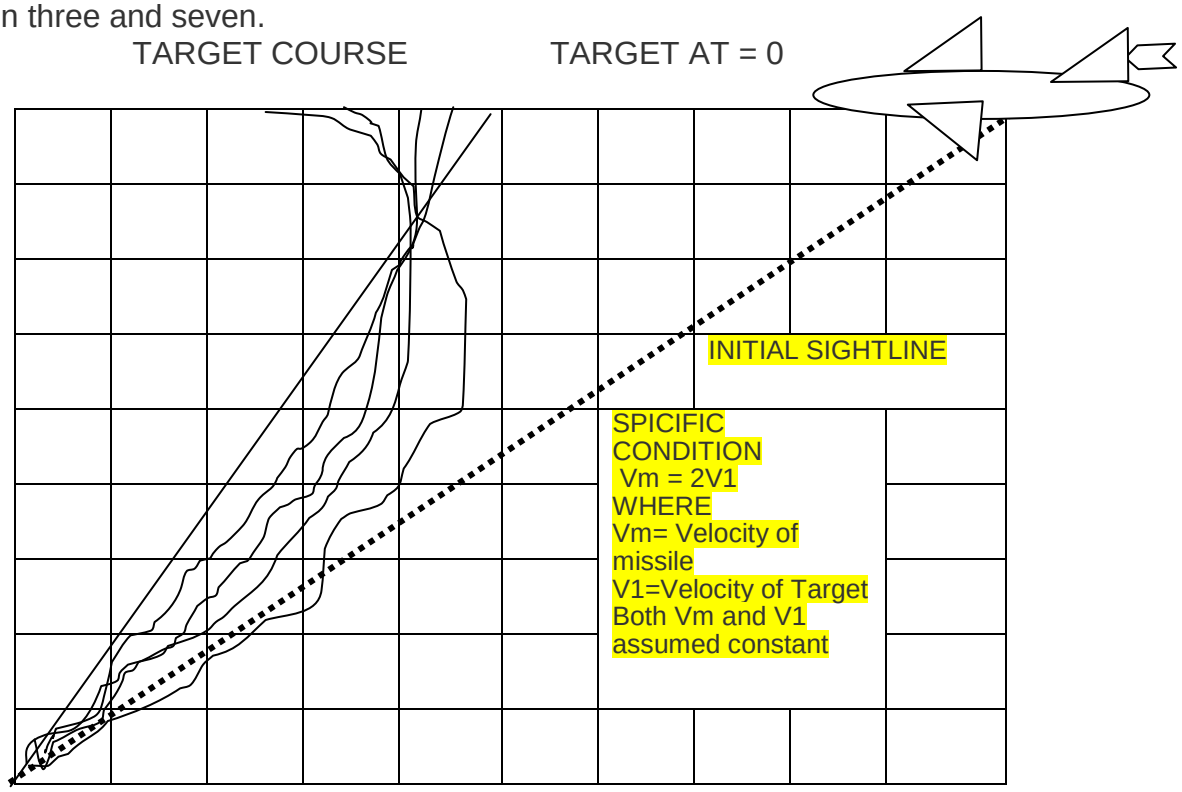
= K Where the rate of turn of the missile flight path is, is the rate of turn of the missile target sightline.

K is a constant of proportionality known as the navigation constant.

The process represented by this equation is known as proportional navigation and, at present, all homing missile employ the method in order to intercept their targets.

45. **Homing Trajectories.** The ideal trajectory for a homing missile would be a collision (or constant bearing) course in which the missile always keeps the target at a fixed (or constant) bearing. With a non-maneuvering target this would result in a straight line trajectory, which is the shortest possible flight path, and on such a trajectory. To achieve such a course is the purpose of proportional navigation and the extent of the achievement depends upon the value of K.

46. When K=1 missile will turn its flight path at the same rate as the sightline: and thus, it initially pointing at the target, should continue to do so, At least this would be so if the demanded latex did not exceed the missile's limiting latex. However, with K=1 the latex demanded can become infinite if the ratio of the missile velocity to target velocity is greater too. Consequently, such a value K-1 the trajecto9ries for specified conditions are shown in Since the miss distance depends on the difference between the maximum demanded latex and the missile's limiting latex, homing missiles usually employ a value of k between three and seven.



Angles at = 0

(Fig-10) Proportional Navigational Trajectories

47. **Measurement of Rate of Turn of Sightline.** As homing missiles require nothing more than the measurement of the rate of turn of missile target sightline, the entire guidance system of such missiles exists to measure this rate accurately. This is a different requirement from defining a line of sight accurately. Thus the servo-mechanism of a homing head is carefully designed so that the rate measurement will be accurate.

48. **Homing Agencies.** Almost any part of the electromagnetic or acoustic spectrum may be used in a homing guidance system to establish the missile-target sightline. However, by far the most commonly used guidance is radar.

49. In the following tow chapters, the application of infrared and radar homing guidance is discussed. Although missiles are classified as active, semi-active and passive homing missiles, it is more convenient to describe the principles involved in the system.

Infrared Homing

50. All bodies whose temperatures are above absolute zero (-274 C) emit infrared (IR) radiation; the higher the temperature of the body the more IR energy it radiates. If the IR radiation from a target can be detected at some distance away and used to distinguish the target from its environment, then a sightline to the target can be established and used to guide a .

51. The basic principles of IR radiation are dealt with in AP 3456K, Part 2, Sect 1, Chap 3; this chapter will be concerned only with the application of IR in missile guidance.

Detection

52. Detecting devices such as thermometers, thermopiles and bolometer are not suitable for use in IR radiation over a very wide bandwidth, whereas the requirements is for a detector which is sensitive only at the wavelengths emitted by the target. Secondly, the sensitivity of the best of them is about 100 times worse than is needed except when they are refined to a form too delicate for use in a missile.

53. The detector used for missile guidance is the Photo conductive cell in which a semiconductor crystal absorbs energy from IR radiation. This absorption produces a charge in the cell's electrical resistance or conductivity so that if a D.C Voltage is applied across the cell there is a change of current proportional to the IR energy incident per second upon the sulphide (Pbs); latter research led to cells of led to cells of lead selonide (Pbs), lead telluride Pate) and Indium antimonite Insb.)

Photo Conductive Detectors

54. Important factors to consider in all photo conductive cells are :

a. **Cut-Off.** Photo conductive cells are frequency sensitive and have a very sharp cut-off, ie they respond very little to IR radiation beyond their longer wavelength limit. It is important to choose a cell whose cut-off is consistent with the emission spectrum of the target.

b. **Time Constant.** In order to obtain continuous accurate information on the alignment of the sightline from missile to target it is necessary to interrupt or "chop" the incident radiation. The frequency response of the cell is related to its time constant and determines the chopping speed required to produce optimum signal response. The time constant may be wavelength-dependent and is affected by temperature. Cooling increases the time constant.

c. **Detectivity.** The effective detectivity of a detector is a measure of its overall signal-to-noise response to incident IR radiation of given spectral characteristics. The detectivity (D*) shown in the table below is a way of describing the ration of responsibility to noise of a cell, such that the actual area of the detector and the bandwidth do not effect the parameter. D* is measured is watt per square centimeter per unit bandwidth of noise.

d. **Cooling.** In photo conductive detectors a rise in cell temperature decreases cell resistance and the increased internal noise. Consequently, detectivity can be improved by cooling Pbs, PbSe, PbTe and InSe, cells to the temperature of liquid nitrogen (77 K) and miniature cooling units on "minicoolers" have been developed for this purpose. Cooling also improves the long wavelength response, but one disadvantage is that the time constant of the cell is increased.

TABLE OF CHARACTERISTICS OF PHOTO-CONDUCTIVE CELLS AT -196 C

Material	Cut-Off wavelength (g)	Detectivity (D*) (Watt per sq cm per Hz)	Time constant (aec)
Lead sulphide (Pbs)	3.7	10 13	3x10-3
Led Slenibe (Pbse)	5.8	10 11	4x10-5
Lead telluride (PbTe)	5.1	10 11	2.5x10-5
Indium antimonide (InSb)	5.7	10 10	10-5

55. PbS as a detector is limited by its cut-off when receiving radiation from hot targets (jet pipes or exhaust stubs). Hence it must operate in the 2 to 2.5 window if uncooled, or, if cooled, may use the 3.3 to 4 window. PbS detectors have the best detectivity but the IR band they use limits a homing missile with such a detector to rear attack only.

56. PbSe, PbTe and InSb, although less sensitive than PbS, have the advantage of a longer wavelength cut-off, and so may operate in the 4 to 5 window. Filters may be used to cut off wavelengths shorter than about 3 thus reducing the effect of bright sky and sun radiation. Such cells give a missile the capability of all round attack against a supersonic target whose skin is heated by air friction.

Optical System

57. Fig 1 shows a simplified block diagram of an IR missile homing head. Ir radiation from the target is reflected by the collecting dish and reflector through the focusing lens on to the photo cell, changing the alectrical resistance of the cell. The cell is connected to a DC source, and the current through the cell reses as the received radiation increases. (By itself, this system does not indicate the direction from which the radiation is coming).

58. **Chopper.** If the target moves away from the optical axis of line of sight of the missile, the target image will move away from the centre of the focal plane of the mirror system. The amount and direction of the displacement are directly related to the target's displacement from the optical axis of the missile. At the focal plane there is a rotating disc with segments alternately clear and opaque to target radiation. Because the target image is small compared with the size of the disc the radiation received from it is interrupted or "chopped", while the general background radiation is not shut off. Thus the cell output now consists of an AC signal whose frequency depends on the number of segments and on the speed of rotation of the chopper. It is this signal that carries information about the target and by using this signal, and not any low frequency or DC signal, the homing head discriminates against unwanted signals arising either externally or internally.

59. **Error Signal .** If part of the disc is blanked out, the signal is interrupted for a longer period once per chopper cycle. The output is now a series of packets of oscillation, the packets at the chopper frequency. The phase relation (or time difference) between the start of each packet and a reference sine wave generated by the motor motor driving the chopper goes the angular orientation, of the target image in the field of view. The system can be arranged to give a measure of radial distance, by various methods of shaping the chopper slits. For instance, if the slits are narrower in angel near the centre than further out, there will be less net radiation per chopper rotation falling on the cell. The error signal (representing the radial distance) is amplified and resolved, and used to turn the IR homing head, which is gyro-stabilized, to follow the missile to target sightline. Sightline information is taken from this system and used in the same manner as described for radar homing.

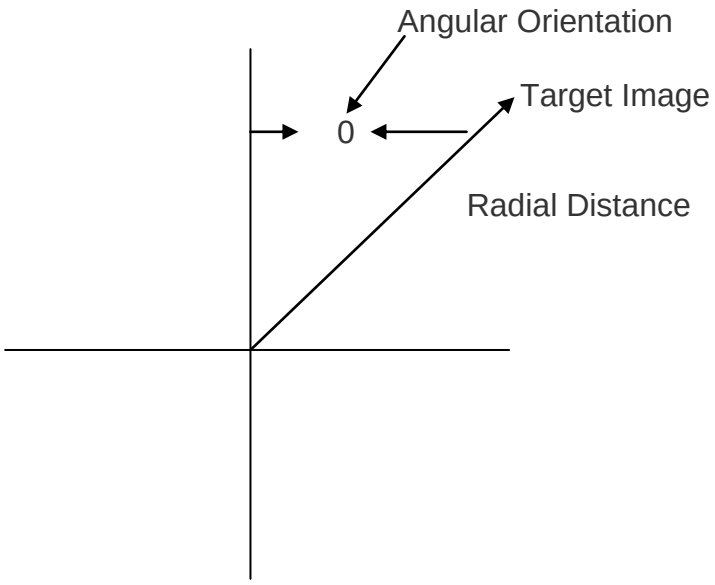


Fig-11 : Plane of target Image and Chopper

Advantages and Limitations of IR Guidance

60. **Advantage**. The advantages of IR guidance are:

a. **Accuracy.** As the wavelength is very short, the accuracy and discrimination are about 0.05. An IR missile can discriminate between two sources a few yards apart at several miles range and generally will home into one particular engine or a multi-engine target. Jitter and noise level are much lower than in a radar system and there is no IR glint. Accuracy improves as the target is approached.

b. **Lethality.** Because of the greater accuracy, an IR homing missile will, for a given warhead and missile weight, have a greater lethality than one guided by radar.

c. **Simplicity.** The missile needs only one small and relatively simple receiver.

d. **Security.** As it is a passive homing missile, it does not give away its presence by radiating any type of energy (However, AI radar is usually employed for air-to-air target detection before an air -to-air IR homing missile is fired).

e. **Tactical Freed on.** As for all homing missiles once the missile has been fired there are no tactical restrictions on the firer.

f. **Difficulties of Applying Countermeasures.** The IR guided missile is homing to a source of energy at the target (either heat or skin heat) which is difficult to mask or to simulate by launching sufficient decoys at the right time and of the precise radiation characteristics sought by the missile. Countermeasures are difficult and in some cases impractical.

61. **Limitations.** The IR homing missile has the following limitations:

a. It cannot be used in cloud.

b. Steady acquisition of the target by the homing head may be impossible within a small angular distance from the sun or bright cloud edges. This difficulty is reduced by the use of cells sensitive to longer wave length and by the use of filters to cut short wavelength background radiation.

c. The ability to attack from any angle is valid only when the target speed is high enough for appreciable skin heating to occur, and when the missile has a detector cell sensitive to wavelengths loner than about six microns. If target speed is subsonic or low supersonic, the missile must home on to the engine or exhaust plume and is therefore limited to a rear attack.

d. No indication of target range is supplied to the attacker by the IR homing head. Some extraneous range finding method is required.

RADAR HOMING

General Considerations

62. The radio band provides the most widely used means of obtaining positional or directional information.

63. When radar is used to establish a line of sight, cent metric (or shorter) wavelengths are essential. These are, however, generally limited in range to the optical horizon and are subject to atmospheric attenuation (eg by water vapour) and to scattering by precipitation. There is also a range limitation imposed on radar homing guided missile because of the limited dish diameter of the guidance aerial and the amount of power which the missile can carry.

64. If more than one target is present in the same general region of space, the problem of target resolution occurs. The targets can only be resolved if their angular separation exceeds some fraction of the beam width. If dish size is limited, good angular resolution can only be obtained if the wavelength employed is small. When too short a wavelength is used however, beam scattering and attenuation results. Thus a compromise is required and it will be seen that the majority of radar homing missile employ the X-band (=3 cm) of frequencies in their guidance systems. For a typical missile operating at X-band and with a 45 cm (18-inch) diameter aerial dish the beam width will be approximately five degrees.

65. With its forward looking aerial, a radar homing missile is very vulnerable to confusion from jamming especially when it approaches a jamming target. (however, if the missile normally employs passive homing, or if when in a jamming environment its mode of guidance can be changed to passive hom-on jam, a target which radiates jamming signals will make itself more vulnerable than a non-jamming target). Nevertheless, homing ranges obtainable by using radar are far greater than those obtainable with other guidance methods. Because of this, many homing missiles make use of radar guidance.

66. Several difficult problems confront the designer of a radar homing missile. The most significant of these are discussed in the following paragraphs.

Source of Error

Radome Aberration

68. Radar guidance aerial dishes present a difficult aerodynamic problem since they do not easily lend themselves to incorporation in a missile body. Such aerial must be provided with streamlined covers (or radomes) capable of sustaining large aerodynamic loads without interfering with the performance of either the radar or the missile. From a purely aerodynamic consideration a very on, pointed radome is required. But to ensure that all radar energy passes through the radome dielectric material at normal incidence (thus avoiding refraction) a hemispherical shape is desirable. The latter shape is largely unacceptable aerodynamically and the former is unsuitable from a radar stand point. The compromise shape is termed an "ogive".

69. An logical radome still causes some reflection of the radar beam passing through it and this is known as radome aberration. The effect of this is to produce a bending or aberration of the apparent sightline. When the missile maneuvers during the homing process, the sightline angle fluctuate this angular movement of thee sightline will produce a chance of aberration. The rate change of this aberration, being non-uniform causes spurious sightline spin rates to be measured by the homing head.

70. At high altitude where the atmosphere is less dense, large angles of wing incidence are required for man oeuvre. For a fixed wing missile, considerable body incidence will be experienced. A moving-wing missile requiring little or nobody incidence will not suffer to the same extent.

Jitter

71. In the process of tracking the target, the radar guidance beam is subject to unwanted random noise or "jitter". This noise comes from two principal sources:

a. **Radar Noise.** Instant-to-instant variations in the quality of radar reflections from the target.

b. **Serve Noise.** Tremors in the tracking aerial position arising from the serve control system driven by the radar signal minute circuit fluctuations; mechanical backlash. Thus spurious movements of the sightline will arise, although they can be smoothed out to some extent by filters. Nevertheless, these spurious sightline movements are interpreted by the missile guidance system as actual target man oeuvres, and steering signals to alter the missile flight path by "K" times the rate of change of sightline angle are generated. Jitter is a random phenomenon and so that the resulting missile motion becomes erratic. The effect of jitter noise decreases as the missile approaches the target.

Glint

72. One of major sources of noise is completely outside the control of the guidance engineer. This is "glint", and it arises because of the fandom motion of the "radar centre" of the target as the echo signal comes first from one part of the target then from another, and so on. Once again, spurious changes of sight line result, and the effect of this becomes increasingly severe as the missile approaches its target.

73. Eventually, when the "range to go" is of the same order as the target dimensions, it may be necessary to cut off the guidance signals and allow the missile to cost for the last few hundred feet to the target. For a typical cut off distance of 500 ft from the target and considering the wrest case of interception (a tail attack) where the missile closing speed is around 1,000 fps, this corresponds to a "time to go" of a half second. If the target, at this instant developed immediately a man oeuvre of 48 sideways, it would move only 16 ft away from the last predicted position of impact. This would often be well within the dimension of the target itself and the effectiveness of a proximity fuze warhead would still be significant.

Low Altitude Limitations

Ground Returns

74. The minimum altitude for the successful operation of a radar homing missile will probably be determined by ground reflections and thus depends on the type of ground and also on the particular form of the engagement. However, whilst this is true for pulsed radar systems, this low-altitude limitation can be removed to a large extent by employing continuous wave (CW) radar techniques which are less affected by reflections from stationary objects.

LONG RANGE GUIDANCE

INERTIAL NAVIGATION

Outline

75. When considering the guidance problem in a long range missile if cannot be assumed that target radiation will be available to establish a line of sight. For long range operations, knowledge is usually available about the positions of the launch point and the target in a particular co-ordinate system. Thus if this knowledge can be used to guide a missile to its target, then no externally supplied information is necessary. All that is required is the means to measure missile movement in frame of reference and to compute the necessary course.

76. Accelerations and directions of movement of a missile may be measured by means of accelerometers and gyros, and the required course may be computed within an established frame of reference. Such a system is called inertial navigation. The uniquence of pure inertial navigation that is that it is self-contained and can operate in all weathers, immune from interference and or countermeasures.

77. **Gyro Wander.** If a gyroscope, perfect in balance and without frictional torques, were to have its spin axis directed at a point in space, it would continue to remain fixed with respect to space irrespective of any motion of the vehicle containing it or of rotation of the Earth beneath it. In practice such an frictional torques inevitably exist. These will cause the gyroscope to wonder or process (ie to alter the direction in space of its spin axis). The system errors thus resulting are time dependent. An essential characteristic of inertial navigation is its excellent short term but relatively poor long term accuracy.

78. The advent of miniaturized inertial systems incorporating extremely low drift rate gyros now enables pure inertial guidance to be used for flight lasting some hours; however, it is usual to apply hybrid techniques, i e to monitor and update the inertial reference prior to release of the missile to ensure satisfactory performance in the free flight pure inertial guidance phase.

Limitations of Pure INS

79. The pure Inertial Navigation System (INS) offers accurate control of both altitude and navigation, but there are operational limitations, such as :

a. **Effort Oscillations.** The INS is set up or "tuned" in relation to the Earth's Centre. Any disturbing input causes the stabilized platform in the system to oscillate at what is known as the Schuler period (84.4 min). Unless damped these oscillations continue at constant amplitude equal to the amplitude of the disturbance and cause errors in the impute of the system particularly of velocity.

b. **Initial Azimuth Alignment.** Before launch, a pure inertial system requires careful land accurate alignment in azimuth. Self alignment may be carried out by gyro-compassing but this alignment procedure may taken up to 25 minutes and power must be kept on in the missile after alignment has been completed. Various optical alignment techniques may be employed but these require special equipment, or special conditions such as good visibility.

c. **Positional Uncertainty**. Inertial guidance is capable of a high degree of accuracy as long as the positions of the launch point and the target are known accurately. Any error in either position will manifest itself as miss distance at the target. This limitation assumes great importance for moblielaunched missiles, where the position of the launching aircraft or submarine might not be known with sufficient accuracy.

80. All of these limitations may be overcome by the use of some form of "mixed inertial system", in which the inertial platform is combined with some other guidance component. Mixed systems may be used to :

a. Damp the Schuler oscillation, thus improving the accuracy of the velocity measurement.

b. Improve the system's estimate of position Oran altitude.

c. Allow azimuth alignment to be carried out, or improved during flight.

Doppler Internal Systems

81. In a Doppler internal system, a reference Doppler velocity is mixed with the inertially derived velocity from the first inter-integrator and the resulting error signal is used to damp the platform's Schuler oscillations.

82. In one application, Doppler inertial mixing is used to improve the accuracy of the simple "programmed out off" guidance system. The velocity error is fed to a computer which calculates the action to be taken by the autopilot, in controlling the motor, to bring the error to zero. In this case only velocity need by computed, so only one stage of integration is required.

83. Doppler inertial mixing may be used to monitor system velocity and to correct for platform tilt; it has no capability for improving position accuracy. For this purpose, monitoring must be effected by a system affording fixing, or positional, information. One such hybrid is the stellar inertial system.

Stellar Inertial Systems

84. Highly accurate stellar inertial systems become feasible with the development of relatively small accurate and reliable daylight star trackers and digital computers. It is new common practice to couple the tracker directly to the inertial platform by mechanical or optical links.

85. The accuracy of present guidance components allows the tracker to "pointed" in space with an accuracy of seconds of etc. It is more accurate, in this case, to use the tracker entirely as a gyro error detector and platform monitor. Position is rarely determined directly and current stellar inertial systems are not necessarily "automatic astro" systems.

86. The direct connection between altitude and position co-ordinate has already been mentioned. Tracking of one or more stars, before or after launch, allows these co-ordinates to be monitored in the following ways:

a. **Single Star Tracking.** Tracking of one star allows the system to determine either position or azimuth or platform vertical.

b. **Two Star Tracking.** The tracking of two stars, either simultaneously by two trackers or sequentially be one tracker, allows the system to determine either position and azimuth, or vertical and azimuth.

87. Daylight stellar acquisition and sequential tracking during the boost phase, were first demonstrated successfully in November 1965. Combinations of the navigation measurements mentioned make possible the use of stellar monitoring to improve missile accuracy in different tactical situations. For a subsurface or air launch altitude may be known accurately, but launch position, or azimuth or both may not be known with any certainty. Stellar monitoring may be employed during the boost phase to correct:

a. Missile azimuth.

b. The computer's knowledge of the launch position.

c. The perimeters of the desired trajectory.

88. For a missile launched from a permanent site, stellar monitoring may be used to monitor the platform and to correct for misalignment caused by the severe vibration encountered during the launch phase.

TASK-14

GUN CAMERA AND AVTR

TYPE-2032 PDR CAMERA GUN (FOR F-7MB)

1. **Introduction** In order to check, analyse the result of a training flight and attack target, the type 2032 camera gun is used on F-7MB aircraft associated with 956 HUD. It is directly connected to the connector on the PDU without cable. The three screws ensures the reliable mechanical connection of the camera to the PDU. The pilot's display recorder (PDR) is in fact a 16mm cine camera with two rows of holes, using black and white films. It is used to record the displayed symbology picture on the pilot's display combiner and the real image from the outside view field, and to make an event mark when required to identify a special meaning.

2. **Composition of the PDR and its operation.** The camera gun consists of the main assembly and the film cassette, which are normally referred to as the camera body and the magazine respectively. These two assemblies are all line replaceable units (LRU).

3. **Camera body**. It consists of lens module, motor, drive mechanism and spring mechanism. The lens module is composed of optical components. Since it is located vertically on the PDU, such arrangement makes the image source from the forward view field direction first be deflected by 78 through a prism and then form an image on the field via the lens assembly and aperture mechanism. The shutter mechanism of the cine camera is made in the same principle as that of the normal cameras. It is used to control the exposure duration with the aperture adjustment ring of f2-f 16. The motor is a DC-driven motor. Its operation voltage is 20 volts which has been regulated by the control circuit from the 27V DC aircraft power supply to the PDU. The control circuit is a multiplex printed circuit board located within the casing. It provides 20V DC voltage to the motor. At the same time, a feedback loop is used to control the r.p.m. of the motor to ensure the film feeding rate at 16 frames per second. The drive mechanism consists of mechanical components. It transfers the driving force of the motor to the drive gear of the magazine to run the film in the magazine. The magazine lock mechanism and the spring mechanism are used for the magazine installation. It can locate and lock the magazine automatically without any tools. When removing the magazine, it is only need to move the magazine latching lever rightward and take out the magazine.

Main Technical Data of PDR

4. a. **View field.**

(1)	Vertical	: 22
(2)	Horizontal	: 16.5

b. Aperture range : f2-f16

c. Focus : f= 25.5mm

d.	Resolution	: Within 6 from the centre of view field 60 lines/mm outside 6 from the centre of view field 40 lines/mm
e.	frame rate	: 16 frames/sec + 5% stabilized within 0.25 sec of start.
f.	Exposure time	: 1/200sec+ 10%
f.	Drive motor	: Integrated 20V DC motor
h.	film capacity:	
	0.1mm base film- 0.15mm base film-	18.3m, 2.5 min run 15m, 2 min run
j.	Picture aperture	: 7.59 X 10.26mm
k.	Picture steadiness	: 0.025mm frame to frame
l.	Delay time	: 0 sec, 2.5 sec, 5 sec and 10 sec.
m.	Power supply	: 27V airborne supply
n.	Cooling	: Air convection cooling
p.	Lens	: 37 X 29 X 38.5mm
	Camera	: 98 X 73.32 X 106mm
	Magazine	: 98 X 24 X 106mm
q.	Weight :	
	Lens Camera Magazine (without film)	: 35g : 755g : 360g
r.	Film type	: 16mm double perforate.

Camera Operation (run)

5. Camera "Off" "On" and "event marker". The camera run is controlled by the camera run selector switch on the PCP and the firing button on the control stick. The selector switch has three positions : "Run", "Off" and "Event mark". "Run" position indicates automatic run of the camera and "Off" position indicates a camera operation in conjunction with the firing button operation from the control stick, which allows pilot to take pictures when firing weapons. The camera is normally set at "Off" position. The "Event mark" position is used to mark significant events by the pilot. This position is a hole-on position, when it is released, the switch returns to the "Run" position automatically.

Delayed film-shot

6, During a firing-shot, once the firing button is released, the camera stops running. In order to record the combat result and the condition after firing weapons, a delay mechanism is prodded in the camera gun. The adjustment device is located on the right side of the camera gun allowing settings of o sec, 2.5 sec 5 sec and 10 sec for delaying time, which means the continuation of camera run for so much time as selected after firing button is released when the camera is operating in the "off" position.

Check Camera on Aircraft

7. a. Check that the camera gun should be reliably installed.

b. The optical module should be clean, their surfaces should have no scratches to influence on the effects of observation and shot.

c. Check for the correct adjustment of iris.

d. Check for the correct installing o magazine in the camera gun, it should be in normal latching mode.

e. The "camera operation selection switch" on PDU control panel should be set to "off" position and the time delay knob to "O" position.

f. Connecting "the ground power supply" to aircraft and turning on "battery, ground power supply" switch, the voltmeter should read 27 + 10%V.

g. Turn on "HUD" and" camera gun" switch on the front right switch board.

h. Turn on "firing/bombing" on the rear right switch boar and set "weapon selecting" switch respectively to "gun"," rocket" and "bomb" position, then check in turn for the synchro shot of the camera gun. When depressing and releasing "firing bombing" button the camera gun should be capable of running normally to perform non-delay shot.

Note : Before checking, you should be sure that there are no real weapons. Otherwise, you are not allowed to check camera.

AVTR SYSTEM
(F-7MB AC)

Introduction

1. The core of AVTR (Air Borne Video Tape Recorders) System is a high resolution colour CCD camera and a digital video cassette recorder. The camera feature is in accordance with Mil-Spec and has been re-encased to meet the aircraft mechanical requirements.

Functional Description

2. **Put Aircraft Battery ON:** AVTR System operates on aircraft battery The system is power up by putting ac at power on & sliding the control switch to standby position, the system is in standby position. At this position, glowing of green LED indicates that the system is operational. If error LED glows at this stage, it will indicate some error (Camera Assembly). For loading or unloading of cassette, operator has to put the system in STBY mode. By sliding the three position switch to 'REC' (record) position, the system starts recording. Whenever, it is desired to stop recoding, slide the switch back to 'STBY' position.

Fault Analysis Guide

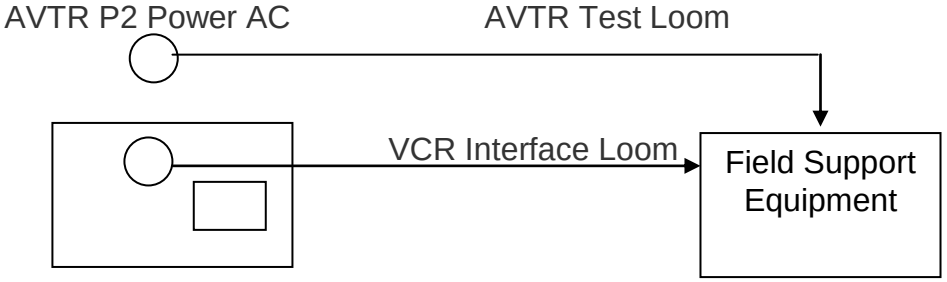
3. **Scope**. This section provides trouble shooting and fault analysis guide for flight line personnel to maintain and ensure the serviceability of AVTR. In case of unserviceability flight line personal can using insolate and replace the fault assembly by using the OLT and following the instructions below.

4. **Assemblies**. AVTR system has two Assemblies:

a.	Recorder Box Assembly	:	0081-130000
b.	Camera Assembly	:	0081-113000

5. **Aircraft Looms**. For some quick fault diagnosis and flight line repair of the ac looms, the signals and wiring diagrams of the looms are also provide at the end of the documents.

6. **OLT Description**. The OLT (Operational Level Tester) of AVTR is provided with the system. This equipment has the ability to diagnose the faulty Assembly of the system and it is also able to identify the problem o f the system. On ac, it uses the ac power supply.



Recorder Box Assembly Fig : Operational of O-Level Tester

Fault Analysis Guide

7. For shop level fault isolation, it can also be operated using 220 Volt AC supply. The system can diagnose the fault of the full system as well as independently for each Assembly. As the system contains LCD display, the video can be observed directly from the Camera Assembly and the focus can be adjusted. It has an eight digit alphanumeric display on which it indicates the status of the Recorder Box Assembly or the fault of the system.

8. **Accessories**. The following equipment is supplied with OLT

a. O-Level Tester (OLT) : 0081-320000
b. VCR Interface Loom : 0081-320600
c. AVTR Test Loom : 0081-320700
d. Demonstration Cassette
e. Operating Manual : 0081-320000-805001

9. **Operating procedure of operational level tester**

Operating procedure of OLT for AVTR is described below:

a. **Full System Assessment**: For isolating the faulty Assembly on Aircraft, following procedure should be followed.

Interconnectivity

(1) Remove connector AVTR-P2 from Recorder Box Assembly.

(2) Connect AVTR Test Loom from one end to AVTR-P2 of aircraft and the other end to J1 connector of the O-Level Tester.

(3) Connect VCR Interface Loom from one end to Recorder Box Assembly and the other end to J2 connector of the O-Level Tester.

b. **Power On**

(1) Power On the Aircraft battery.

(2) Switch ON the AVTR Circuit Breaker (CB).

(3) Put control switch of Camera Assembly from “OFF” to “STBY” position.

(4) Put the O-Level Tester “S1” to “ON”, the “POWER LED “ will glow on O-

(5) Level Tester. All LEDs on Camera Assembly will glow momentarily.

(6) ERROR LED will then glow on Camera Assembly.

(7) The voltage indicator must indicate 28V + 4.

c. **Self Test**

(1) As the switch S1 on O-Level Tester is positioned to ON, a Cross hatch pattern will be displayed on status display. This shows that self-test is under progress.

Indication	Name	Description
ERROR+STANDBY	No LANC	Recorder error
REC+ERROR+STANDBY	DEW indication	DEW in Recorder
ERROR+RECORD	NO Video	No video from Camera Assembly
ERROR	No cassette	No cassette in Recorder
ERROR	End of tape	Cassette has reached its end

Table 4-1: Fault Isolation Table

(2) Observe video output of Camera Assembly on display if no video is available on display, reset the Camera, if still video is not available then replace the Camera Assembly.

(3) Operate control switch of Camera Assembly to REC position, REC LED should glow on Camera Assembly and O-Level Tester should display the RECORD message, carry out recording for five minutes.

(4) During recording, Press EMK switches S3 after each minute for two to three seconds.

(5) Operate control switch of Camera Assembly to STBY position, STANDBY message will be displayed on O-Level Tester. At the end of the test the status display will display no cassette.

d. **Procedure**

(1) Put switch S7 to CAM VIDEO position and switch S8 to System A/V position.

(2) Put switch S2 O-Level Tester on 12V. The voltage indicator must indicate 12V.

(3) Turn on the GVD 800E by sliding the ‘Power’

NOTE

During normal operation error LED should not turn ON. Detail of LED glowing on camera Assembly is as follows

(4) Put switch S7 of O-Level Tester to VCR VIDEO position and ensure GVD 800E is ON. (LED’s on Camera Assembly will switch off)

(5) Press switch S4 to RWD position, then press switch S6 to STBY position after one minute. Press switch S5 to PLAY position and observe recorded audio and video. Observe Event mark indication on top left corner of display along with audio tone.

(6) If all tests are clear, the system is serviceable. Remove the O-Level tester and connect AVTR-P2 back to Recorder Box Assembly.

TASK-15

CONCEPTS OF INFORMATION AND COMMUNICATIONS TECHNOLOGY (ICT) AND e-GOVERNANCE

What is ICT

1. ICT is an acronym that stands for **Information and Communications Technology**. In present days perspective it consists of 3 technologies. They are:

a. Information Technology.
b. Computer Technology.
c. communication Technology.

2. However, apart from explaining an acronym, there is not any universally accepted definition of ICT. Because the concepts, methods and application involved in ICT are constantly evolving on an almost daily basis. It is difficult to cope with the changes as they happen so fast. If we focus on the three words **INFORMATION, COMMUNICATIONS and TECHNOLOGY** behind ICT, we would find that a good way to think about ICT is to consider all the uses of digital technology that already exist t help individuals, businesses and organizations to use information. So, we can say ICT covers anything that will store, retrieve, manipulate, transmit or receive information electronically in a digital form. For example. personal computers, digital television, e-mail, robots. So ICT is concerned with the storage, retrieval, manipulation, transmission or receipt of digital data. Importantly, it is also concerned with the way these different uses can work with each other.

3. Information and Communication Technology or ICT, is often used as an extended synonym for information technology or IT. But in a more specific term that stresses the role of unified communications and the integration of telecommunications (telephone lines and wireless signals), computers as well as necessary enterprise software, middleware, storage and manipulate information.

4. The phrase ICT had been used by academic researchers since the 1980s, but it became popular after it was used in a report to the UK government by Dennis Stevenson in 1997 and in the revised National Curriculum for England, Wales and Northern Ireland in 2000. The term ICT is now also used to refer to the convergence of audio-visual and telephone networks with computer networks through a single cabling or link system. There are large economic incentives (huge cost savings due to elimination of the telephone network) to merge the audio-visual, building management and telephone network with the computer network system using a single unified system of cabling, signal distribution and management.

5. In business, ICT is often categorized into two broad types of products:

a. **The Traditional computer-based technologies** Things we can typically do on a personal computer or using computers at home or at work.

b. **Digital Communication Technologies** Which is more recent and fast-growing and allows people and organizations to communicate and share information digitally.

6. The term Infocommunications is used in some cases as a shorter form of Information and Communications Technology. In fact Infocommunications is the expansion of telecommunications with information processing and content handling functions on a common digital technology base.

7. ICT is nothing but all electronic technologies used in creating, storing, processing, communication and disseminating information of all kinds. So, in modern world every organization possesses at least some ICT resources. Even, most of the people living in this world is provided with ICT related facilities and having ICT resources of their own.

ICT Citizen Services in Bangladesh

8. Some of the notable ICT citizen services aval in Bangladesh is listed below:

a. Agriculture: Agriculture Information & Communication Center (AICC)

b. Driving License

c. Submission of Income Tax Return

d. Law and Order-Online GD Filling

e. Passport and Visa

f. Job Recruitment Process

g. Company Registration in One Day

h. e-Health

j. Utility Services Bill Payment System [WASA, Gas & Electricity]

k. Computerized Land Management System

l. Hajj Management System

m. Poling Station Information-Bangladesh Election Commission

n. Voter Database-Bangladesh Election Commission

p. Railway Ticket Reservation System

q. Service Tracking System-BOI

r. Daily Market Price, DAM

s. Automation of Chittagong Customs House

t. Accessing Long and Short PDS

u. Management Information System, RAJUK

v. Law Web Portal

w. Disaster Forecasting System-Ministry of Food and Disaster Management

x. GIS-based Education Planning-BANBEIS

y. GIS-based Agriculture Resource Planning-Planning Commission

z. Process Automation-Bangladesh Bank

aa. Automatic Clearing House-Bangladesh Bank

ICT Resources In BAF

9. Some of the notable BAF ICT resources of BAF are listed below:

a. BAF PABX Exchanges.

b. BAF ISP Equipments.

c. Mobile Phones.

d. Computers.

e. Network Eqpts (Routers, Media Converters, Ethernet Switches etc)

f. Optical Fiber Links between diff areas.

g. BAF VoIP Sys.

h. Microwave Radio Eqpts etc.

e-Governance

What is e-Governance

10. In simple words, e-Governance is the use of a range of modern Information and Communication Technologies such as Internet, Local Area Networks, mobiles etc by Government to improve the effectiveness, efficiency, service delivery and to promote democracy.

11. Several dimension and factors influence the definition of e-Governance. The word “electronic” in the term e-Governance implies technology driven governance. e-Governance is the application of Information and Communication Technology (ICT) for delivering government services, exchange of information communication transactions, integration of various stand-alone systems and services between Government-to-Citizens (G2C), Government-to-Business (G2B), Government-to-Government (G2G) as well as back office processes and interaction s within the entire government frame work. Through the e-Governance, the government services will be made available to the citizens in a convenient, efficient and transparent manner. The three main target groups that can be distinguished in governance concepts are Government, citizens and businesses/interest groups. In e-Governance, there are no distinct boundaries. Generally four basic models are available-Government to Customer (Citizen), Government to Employees, Government to Government and Government to Business.

Governance : An Information Perspective

12. From the information perspective, following aspects are mentionable to describe governance:

a. Representative democracy relies on supposition that best way to make a decision is wider participation for all its citizens having access to relevant information.

b. Government is by nature an information intensive organization.

c. Information is power and information management is political.

Governance : In IT Framework

13. From the IT frameworks perspective, following aspects are mentionable to describe governance:

a. Expansion of Internet and electronic commerce, is redefining relationships among various stake holders in the process of Governance.

b. A new model of governance would be based upon the transactions in virtual space, digital economy and dealing with knowledge oriented societies.

c. Electronic Governance is an emerging trend to re-invent the way the Government works.

e-Governance : Focus

14. The main focus of e-Governance are:

a. Greater attention to improve service delivery mechanism

b. Enhancing the efficiency of production

c. Emphasis upon the wider access of information

Why e-Governance?

15. e-Governance can transform citizen service, provide access to information to empower citizens, enable their participation in government and enhance citizen economic and social opportunities, so that they can make better lives, for themselves and for the next generation.

16. With the advent of Internet technology, in the early part of the last decade, the developed countries coined the concept of e-governance. Policy makers of the developed countries utilized the new developments in ICT and especially the TCP/IP protocol, in achieving the objectives of good governance. So, the term e-Governance can be defined as efficient and effective use of modern ICT technology for good governance in any country. E-governance can also be defined as Electronic State Management System based on information and communication technologies (ICT), including the Internet technology.

17. The ultimate objective of e-Governance is to establish good governance. The attributes of good governance can be indentified as follows: honesty, efficiency, effectiveness (in terms of time, space and money), fairplay, reliability, participatory democracy, accountability, accessibility, transparency, equity and vision in decision making. All these can be achieved through proper implementation of e-governance using the state of the art technologies.

Conclusion

18. In the present changing scenario governance has wider significance and it is merged with application of ICT to yield and equitable development of the society. For a developing country like, Bangladesh, effective implementation of e-Governance is not always easy for various constraints. It lacks infrastructural setup, expertise in ICT workforce, and economic resources. The present global arena caters for civil society,

business groups and government to facilitate development activities. Government has to play multidimensional role and hence-e-governance requires participation of all these agencies. Private sector should be involved to extend e-Governance activities along with state owned telecom operators. Business oriented private telecom operators concentrate in the capital or large cities leaving behind the rural community. They can work in ‘connecting the citizen’ part through mobile devices with cheaper access to technology. The government policy formulation should be prompt, inclusive, and relevant to the present and future need. In parallel, the government should focus on capacity building in public workforce. E-Governance can essentially meet the goal of ‘Digital Bangladesh’ by digitization of the entire government framework and delivering e-services to all level of the citizen ensuring a corruption free equitable society.

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