MIDTERM EXAM QUESTIONS BANK FOR AVIONICS 2023

Q1. Explain briefly the followings;

1. The importance and role of Avionics .
2. Goal of Avionic systems .
3. Main avionic subsystems can be grouped into five layers according to their role and function.

Answer :

1.

Importance and role of Avionics

- Systems which interface directly with pilot
- Aircraft state sensor systems
- Navigation systems
- External world sensor systems
- Task automation systems.
- Million dollar business , 30% of total cost of aircraft --- avionics equipments
- 40% - maritime/patrol/anti submarine aircraft
- 75% - Airborne early warning aircraft. 22
- The avionic systems are essential to enable the flight crew to carry out the aircraft mission safely and efficiently.
- Mission: Carrying the passengers to their destination, intercepting a hostile aircraft, attacking a ground target, reconnaissance or maritime patrol. – In military operations, reconnaissance is the exploration outside an areaoccupiedby friendly forces to gain information about natural features and enemy presence.
- By automation of tasks, the crew s workload can be minimized.
- The reduction in weight is also significant and can be translated into more passengers or longer range on less fuel.
- The crew comprises of two members namely, the first pilot/ captain and the second pilot.

2. Goal of Avionic systems is

- increased safety

- Air traffic control requirements
- All weather operation
- Reduction in fuelconsumption
- Improved aircraft performance and control
- Handling and reduction of maintenance costs

3. Main avionic subsystems can be grouped into five layers according to their role and function.
    - Systems which interface directly with the pilot.
    - Aircraft state sensor systems
    - Navigation systems
    - External world sensor systems
    - Task automation systems

Q2. Draw and explain the Aircraft Structure and the main parts of a plane.

Answer :

There are lots of parts in a plane, but there are main parts, such as;

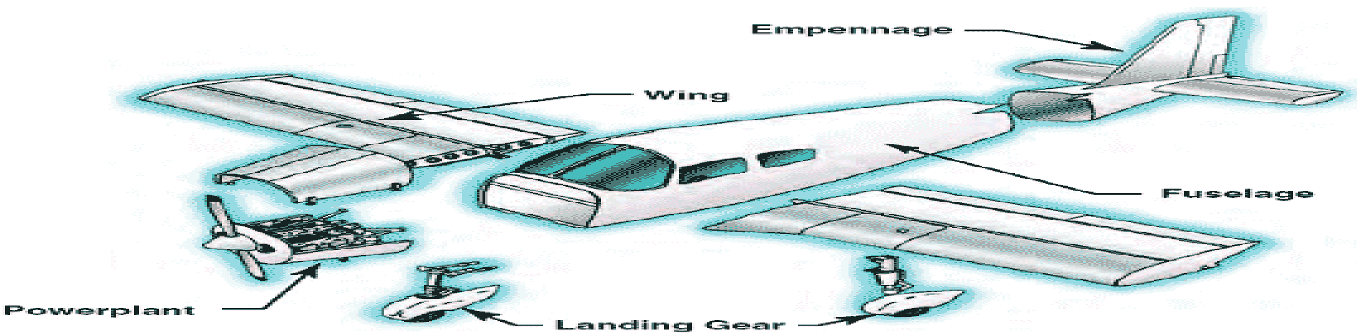
The Fuselage,

The Empennage

The Wings

Power plant (Engine) Landing Gear

Basic Aerodynamics



Q3.

1. What are the main flight control systems .

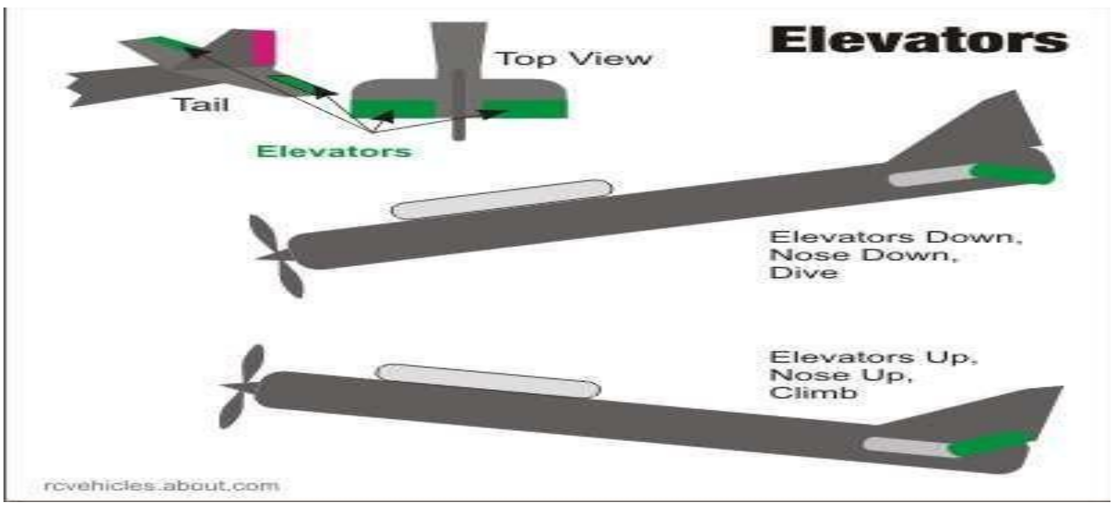
Answer: the main flight control systems are ;

- Aircraft Flight Control Systems
- Primary Flight Controls
- Secondary Flight Controls
- Auxiliary Flight Controls
- Autopilot

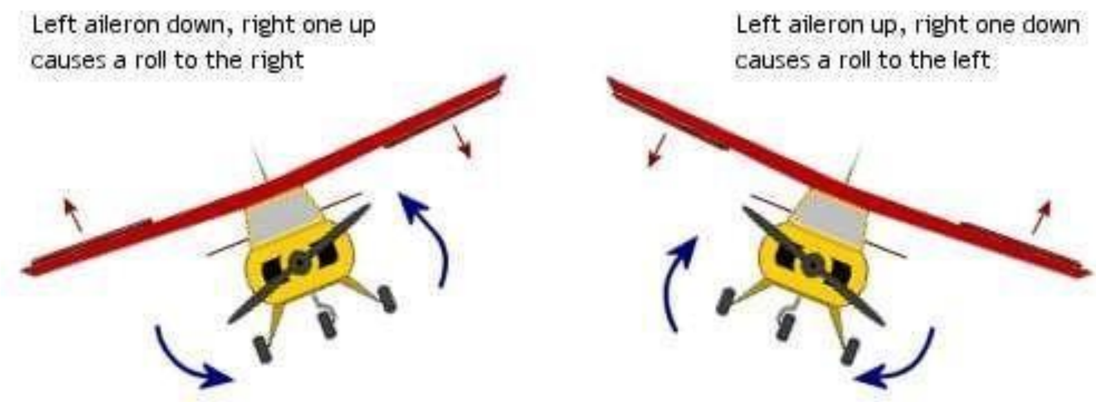
2. Explain and draw the main parts of primary flight control system .

- Answer :
- Elevator Control System
- Aileron Control System
- Rudder Control System

Elevator Control System

- An elevator is mounted on the back edge of the horizontal stabilizer.
- They move up and down together.
- When the pilot pulls the stick backward, the elevators go up. And vice versa.
- This makes the wings fly at a higher angle of attack which generates more lift and more drag.
- Pitch movement
- 

- Aileron Control System
- Ailerons are mounted on the trailing edge of each wing.
- They move in opposite directions.
- When the pilot moves the stick left, the left aileron goes up and the right aileron goes down.
- A raised aileron reduces lift on the upward aileron and a lowered one increases lift

- Centering the stick returns the ailerons to neutral maintaining the bank angle.
- The plane will continue to turn until opposite aileron motion returns the bank angle to zero to fly straight.
- Longitudinal axis
- 

- Rudder Control System
- Mounted on the back edge of the fin in empennage.
- When the pilot pushes the left pedal, the rudder deflects left.
- Pushing the right pedal causes the rudder to deflect right.
- Deflecting the rudder right pushes the tail left and causes the nose to yaw right.
- Centering the rudder pedals returns the rudder to neutral and stops the yaw.

- 

Q4. Explain and draw the flow chart of the principles of operation of the pilot system

Answer :

- An autopilot is a mechanical, electrical, and hydraulic system used to guide an aero plane without assistance from the pilot.
- The pilot is relieved of most of the physical & mental fatigue of controlling an aircraft and is free to devote his attention to the management and direction of progress of the flight.
- On newer aircrafts today, the Autopilot has evolved into a complex feature encompassing microprocessors and decision making systems which take over the complete control of an aircraft from take-off to landing.

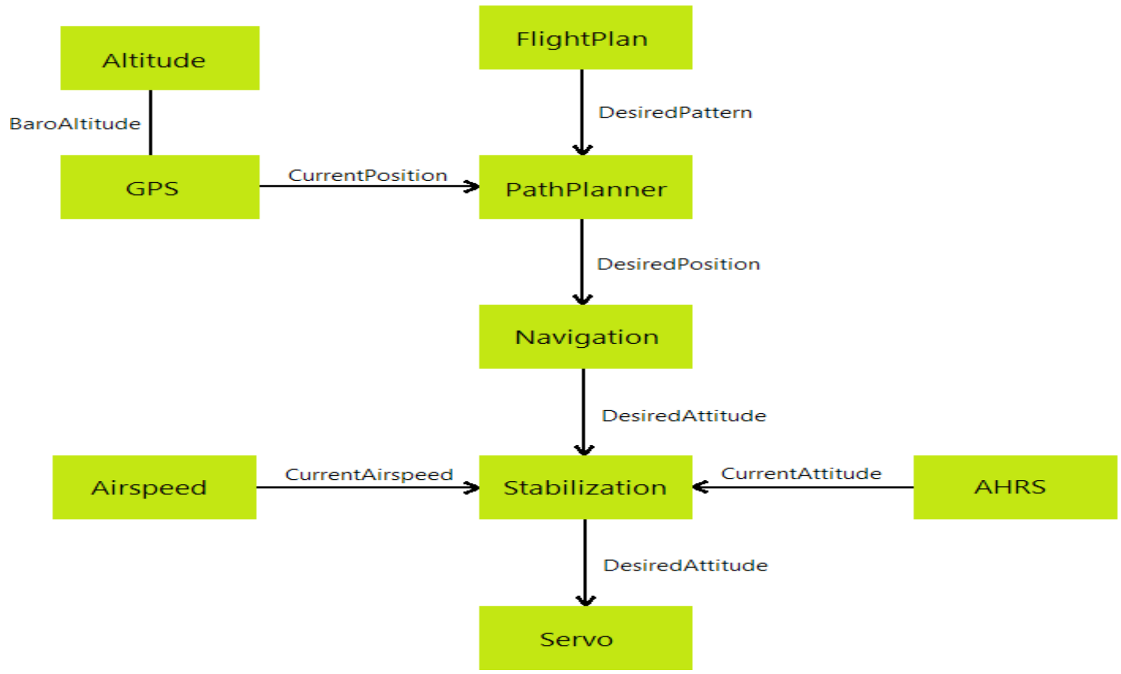
<u>Input to system</u>

1. Pilot commands
2. Sensors on exterior

3. Gyroscope
4. Accelerometer
5. Altimeter
6. GPS
7. ILS

Output from system

1. Servo motors
2. Actuators on exterior
3. Spoilers
4. Rudder
5. Elevator
6. Ailerons
7. Engines



Q5.

1. What are the six basic aircraft instruments and explain the pitot tube instruments briefly with drawing ?

   Answer : A quick scan of the six pack provides the pilot with current information on aircraft speed, altitude, climb/descent, attitude, heading, and turning/banking. Individually, the six pack instruments are:

   PITOT TUBE INSTRUMENTS

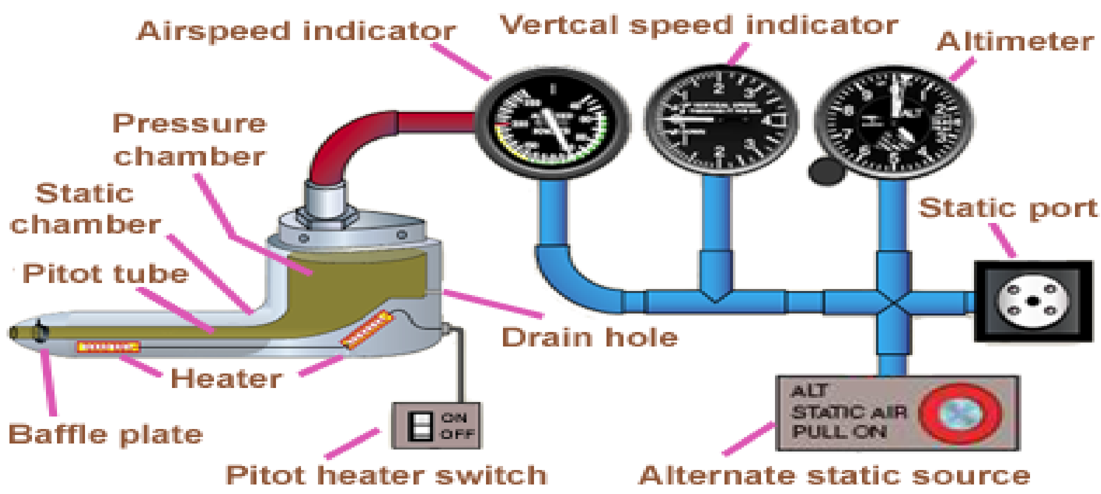
   - Airspeed Indicator (ASI)
   - Altimeter
   - Vertical Speed Indicator (VSI)
   - GYROSCOPE INSTRUMENTS

- Attitude Indicator (AI)
- Heading Indicator (HI)
- Turn Coordinator (TC)

- The following instruments are works by using pitot tube.
- Airspeed Indicator (ASI)
- Altimeter
- Vertical Speed Indicator (VSI)

Pitot Heater is used to prevent or melt the ice in high altitude

Static port is maintain atm.pressure with respect to altitude.



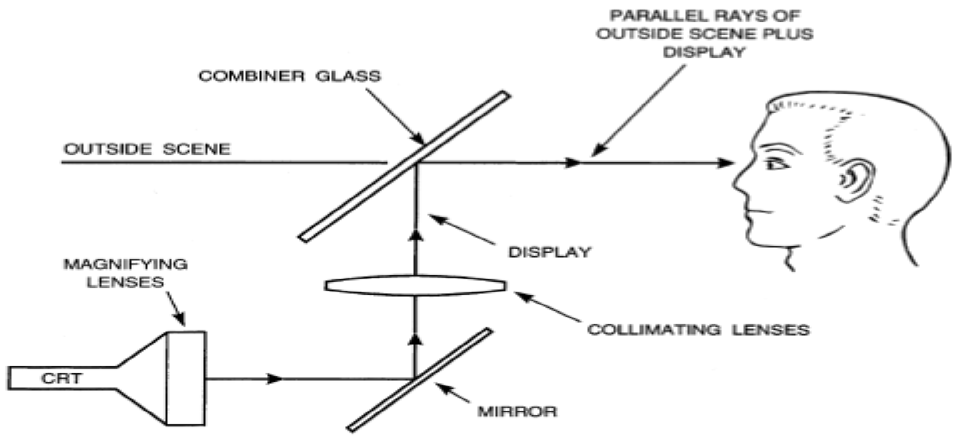
Source: www.faa.gov/handbooks_manuals/media

Q6. Draw and explain the basic principle configuration of a Head Unit Display HUD .

Answer :

The basic configuration of a HUD is shown schematically in Figure 1. The pilot views the outside world through the HUD combiner glass (and windscreen). The combiner glass is effectively a 'see through' mirror with a high optical transmission efficiency so that there is little loss of visibility looking through the combiner and windscreen. It is called a combiner as it optically combines the collimated display symbology with the outside world scene viewed through it. Referring to Figure 1 , the display symbology generated from the aircraft sensors and systems (such as the INS and air data system) is displayed on the surface of a cathode ray tube (CRT). The display images are then relayed through a relay lens system which magnifies the display and corrects for some of the optical errors which are otherwise present in the system. The relayed display images are then reflected through an angle of near 90◦ by the fold mirror and thence to the collimating lens which collimates the display images which are then reflected from the combiner glass into the pilot's forward field of view. The virtual images of the display symbology appear to the pilot to be at infinity and overlay the distant world scene, as they are collimated. The function of the fold mirror is to enable a compact optical configuration to be achieved so that the HUD occupies the minimum possible space in the cockpit.

The fundamental importance of collimation to any HUD system merits further explanation for the benefit of readers whose knowledge of optics needs refreshing.



Q7. Draw the block diagram of the HUD Electronics and explain the operation of the functional elements .

Answer :

The basic functional elements of a modern HUD electronic system are shown in Figure 2. These functional elements may be packaged so that the complete HUD system is contained in a single unit, as in the Typhoon HUD above.

The system may also be configured as two units, namely the Display Unit and the Electronics Unit. The Display Unit contains the HUD optical assembly, CRT, display drive electronics, high and low voltage power supplies. The Electronics Unit carries out the display processing, symbol generation and interfacing to the aircraft systems.

The new generation of aircraft with integrated modular avionics use standardized cards/modules to carry out the HUD display processing and symbol generation tasks. These are housed in a rack in one of the environmentally controlled cabinets.

The basic functional elements of the HUD electronics are described briefly below.

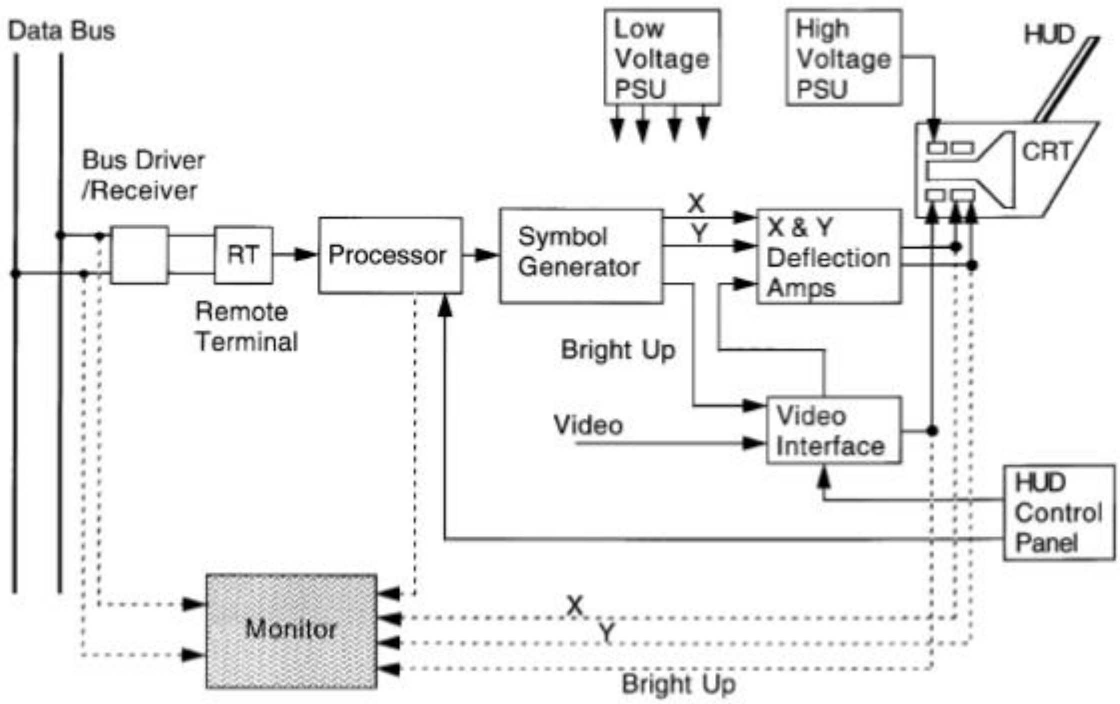
The data bus interface decodes the serial digital data from the aircraft data bus (typically a MIL STD 1553B data bus) to obtain the appropriate data from the aircraft sub-systems and inputs this data to the display processor.

The input data includes the primary flight data from the air data system and the INS, such as height, airspeed, vertical speed, pitch and bank angles, heading, flight path velocity vector. Other data include MLS or ILS guidance signals, stores management and weapon aiming data in the case of a combat aircraft, discrete signals such as commands, warnings, etc.

The display processor processes this input data to derive the appropriate display formats, carrying out tasks such as axis conversion, parameter conversion and format management. In addition the processor also controls the following functions:

- Self test,
- Brightness control (especially important at low brightness levels),
- Mode sequencing,
- Calibration,
- Power supply control.

The symbol generator carries out the display waveform generation task (digitally) to enable the appropriate display symbology (e.g. lines, circles, alpha-numeric, etc.) to be stroke written on the HUD CRT. The symbols are made up of straight line segments joining the appropriate points on the display surface in an analogous manner to a 'join the dots' child's picture book. Fixed symbols such as alpha-numeric, crosses, circles (sized as required) are stored in the symbol generator memory and called up as required. The necessary D to A conversions are carried out in the symbol generator which outputs the appropriate analogue x and y deflection voltage waveforms and 'bright up' waveforms to control the display drive unit of the HUD CRT.



Q8. What are the main advantages of a HUD in a civil aircraft ?

Answer The main advantages of a HUD in a civil aircraft are:

1. Increased safety by providing a better situational awareness for the pilot to control the aircraft by the head up presentation of the primary flight information symbology so that it is conformal with the outside world scene.

2. The HUD can also provide a flight path director display which allows for the effect of wind shear from a knowledge of the aircraft's velocity vector, airspeed, height and aerodynamic behavior.

2. Increased revenue earning ability by extending operations in lower weatherminima. The HUD is used to monitor the automatic landing system and to enable the pilot to take over on aircraft which are not equipped to full Category III automatic landing standards (automatic landing systems .

3. Use of the HUD as part of an enhanced vision system to enable operations in lower weather minima at airfields not equipped with automatic landing aids (ILS/MLS). For example, the number of Type II and Type III ILS facilities in the US is very limited – typically less than 70.

4. The use of the HUD for displaying ground taxiway guidance is being actively investigated, and is considered a likely extension to the HUDs roles. Ground taxiway guidance could be provided by differential GPS.

Q9. Draw and explain the operation of the Head Tracking Systems and explain the types of these systems?

The need to measure the orientation of the pilot's head to determine the angular coordinates

of the pilot's line of sight with respect to the airframe axes . It should be noted that the problem of measuring the angular orientation of an object which can both translate and rotate can be a fundamental requirement in other applications such as robotics. In fact the solutions for head tracking systems

can have general applications. Space does not permit a detailed review of the various head tracking systems which have been developed. Most of the physical effects have been tried and exploited

such as optical, magnetic and acoustic methods.

Optical tracking systems work in a number of ways, for example,

(a) Pattern recognition using a CCD camera.

(b) Detection of LEDs mounted on the helmet.

(c) Sophisticated measurement of laser generated fringing patterns.

Magnetic tracking systems measure the field strength at the helmet from a magnetic field radiator located at a suitable position in the cockpit.

Q10. Explain and draw the binocular HMD (BHMD) Helmet Mounted Display and the Virtual Cockpit?

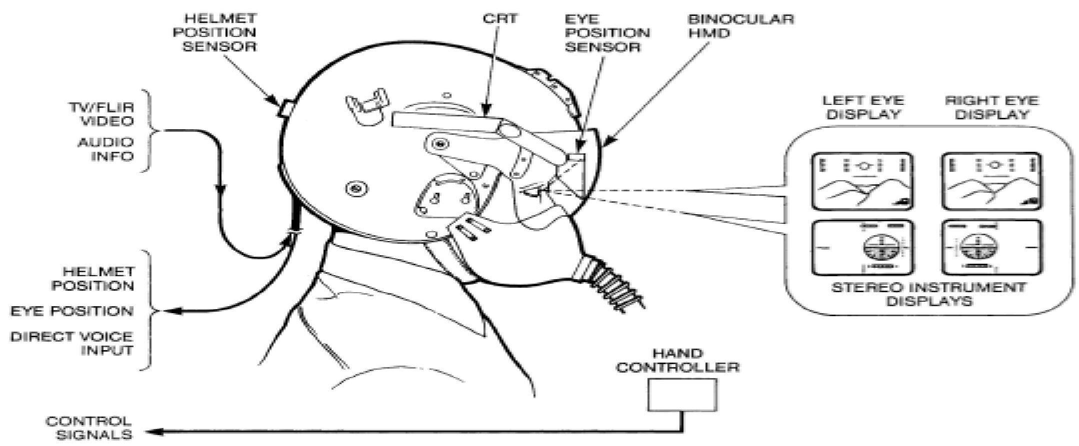
Answer :

The concept of a ‘virtual cockpit’ where information is presented visually to the pilot by means of computer generated 3D imagery is being very actively researched in a number of establishments both in the USA and the UK.

A correctly designed binocular HMD (BHMD) is a key component in such systems because it is able to present both a display of information at infinity and also stereo images to each eye so that the pilot sees a 3D image. It should be emphasized that the BHMD optical system needs to be accurately designed and manufactured in order to achieve a good stereoscopic capability.

The ability to generate 3D displays opens up entirely new ways of presenting information to the pilot (and crew), the objectives being to present the information so that it can be visually assimilated more easily and in context with the mission.

Figure 1 illustrates the use of a BHMD to implement such a system. When head up, the pilot views the outside world directly, or indirectly by means of a TV display on the HMD from a head steered gimballed electro-optical sensor unit (e.g. infrared imaging sensor, low light TV camera or CCD camera) When looking down at the instrument panel, the virtual cockpit computer system recognizes the pilot’s head down sight line from the head tracker output and supplies this information to the display generation system. The display generation system then generates a stereo pair of images of the appropriate instrument display on the panel which corresponds to the pilot’s sight line. Thus, looking down into the cockpit at the position normally occupied by a particular instrument display will result in the pilot seeing a 3D image of that instrument display appearing in the position it normally occupies .



Binocular HMD and virtual cockpit.

Q11. Explain with drawings the Civil Cockpit Head Down Displays?

Answer:

The electronic Primary Flight Display (PFD) replaces six electro-mechanical instruments:

altimeter, vertical speed indicator, artificial horizon/attitude director indicator,

heading/compass indicator and Mach meter.

Figure 1, shows a representative primary flight display. Airspeed is shown on a scale on the left with pressure altitude and vertical speed on the right hand scales. Aircraft heading information is shown on a 'tape' scale type format below the attitude display. The artificial horizon/attitude display has a blue

background above the horizon line representing the sky and a brown background

below the horizon line representing the ground. This enables 'which way is up' and

the aircraft orientation to be rapidly assimilated by the pilot in recovering from an

unusual attitude, for example, as the result of a severe jet upset.

Primary flight display (by courtesy of Airbus).

Q13 . What are the main aircraft navigation systems and explain two of them with drawings ?

Answer :

The main aircraft navigation systems

- ✓ VHF OMNIDIRECTIONAL RANGE (VOR)
- ✓ INSTRUMENT LANDING SYSTEM (ILS)
- ✓ DISTANCE MEASURING EQUIPMENT (DME)
- ✓ AUTOMATIC DIRECTION FINDERS (ADF)
- ✓ DOPPLER NAVIGATION SYSTEM

- ✓ INERTIAL NAVIGATION SYSTEM

VHF OMNIRANGE SYSTEM (VOR)

- ✓ VOR, short for VHF omnidirectional radio range, is a type of radio navigation system for aircraft, enabling them to find their position and stay on course by receiving radio signals emitted by a network of radio beacons. It uses frequencies in very high frequency (VHF) from 108 to 117.95 MHz.

- ✓ VHF Omnidirectional Radio Range (VOR), is an aircraft navigation system operating in the VHF band. VORs broadcast a VHF radio composite signal including the station's Morse Code identifier (and sometimes a voice identifier), and data that allows the airborne receiving equipment to derive the magnetic bearing from the station to the aircraft. This line of position is called the "radial". Alternatively, the VOR radial may be combined with magnetic heading from the aircraft compass to provide a bearing relative to the aircraft axis, which cn be used to home to the beacon. VOR beacons are frequently used as way-points on conventional Airway systems, or as the basis for a Non-Precision Approach.

- ✓ It produces 360 usable radials or courses ,any one of which is radial path connected to the station.

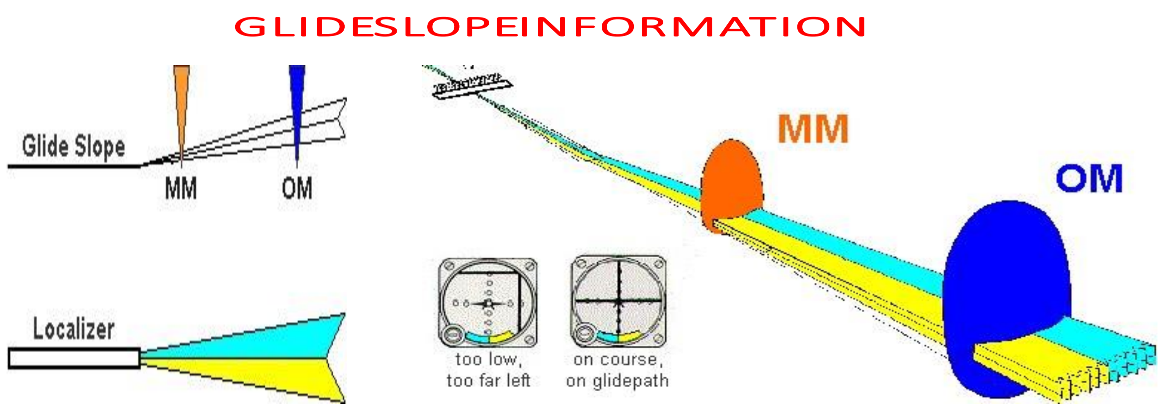
INSTRUMENT LANDING SYSTEM (ILS)

- ✓ It Operates in the VHF portion of the electromagnetic spectrum

- ✓ System consists of a runaway localizer, a glide slope signal, and marker beacons for position location

- ✓ Localizer equipment produces a radio course aligned with the centre of an airport runaway. The on course signals result from the equal reception of two signals; Blue sector(150 Hz) and yellow sector(90 Hz)

- ✓ In aviation, the instrument landing system (ILS) is a radio navigation system that provides short-range guidance to aircraft to allow them to approach a runway at night or in bad weather.



Q14 . Explain with drawings the marker beacons which is used in landing instrument system .

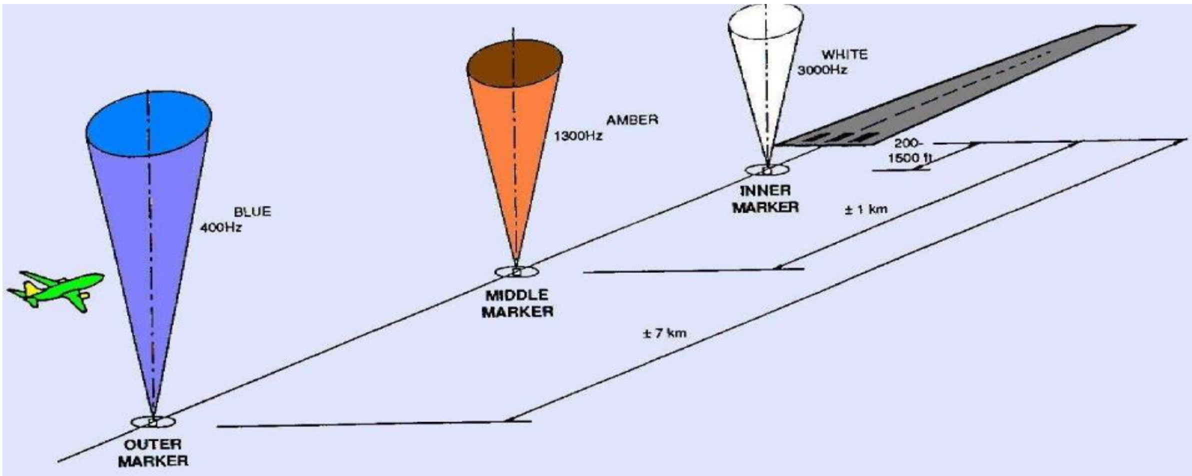
Answer :

- ✓ In connection with the instrument landing system.
- ✓ signals which indicate the position of the aircraft along the approach to the runway
- ✓ Three markers are used in each installation:
- ➢ Outer marker - the beginning of the approach path

is modulated by a 400 HZ signal, a tone keyed in long dashes

- ➢ Middle marker: 3500 ft from the end of the runway

is modulated at 1300 Hz, a higher-pitched tone keyed with alternate dots and dashes

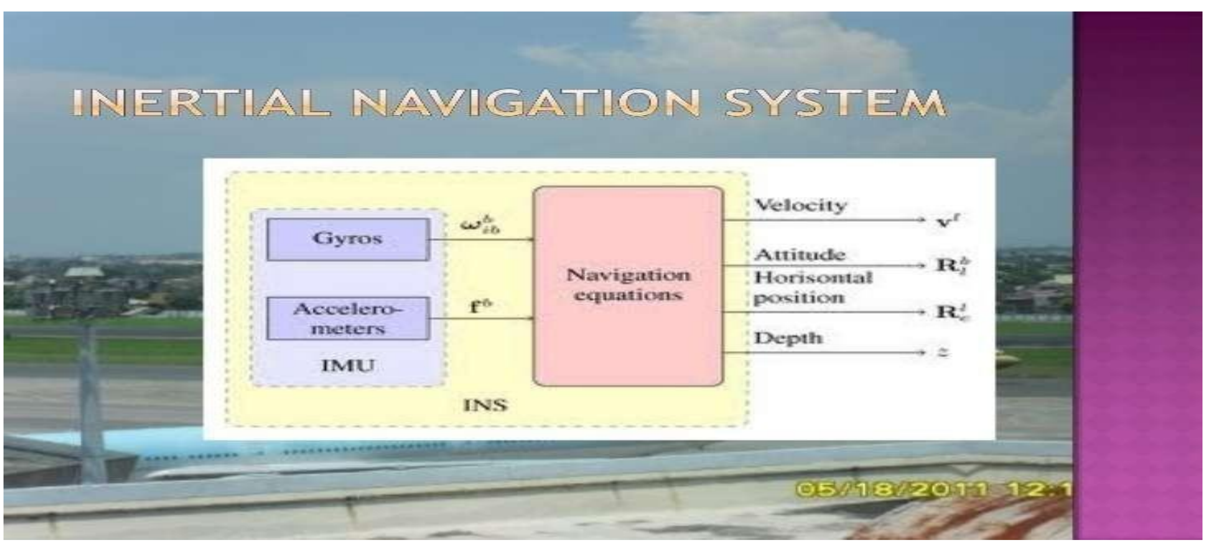


Q15 . Design the block diagram of the inertial navigation system and explain the function of each block .

Answer :

An inertial navigation system is a complex containing four basic components :-

- ✓ A stable platform which is oriented to maintain accelerometers horizontal to the earth's surface.
- ✓ Accelerometers arranged on the platform to supply specific components of acceleration
- ✓ Integrators which receive the output from the accelerometers and furnish velocity and distance.
- ✓ A computer which receives signals from the integrators and changes distance travelled to position in selected coordinates.



Q.16

1. Draw the operational drawing of the Radio altimeter and explain how it is working ?

2. If the aircraft altimeter is 5km and the speed of light is 3x100 Mm/sec , calculate the delay .

Answer :

The Radio altimeters are based on the principle of reflection of electromagnetic wave pulses by the surface of the earth or sea. These waves fall within the radio spectrum range. Electromagnetic waves travel at the speed of light and thus the calculation of the distance is effectively immediate. Although they are affected by surface irregularities generating deviations in the radio signal, radio altimeters provide a reliable and accurate method of measuring height.

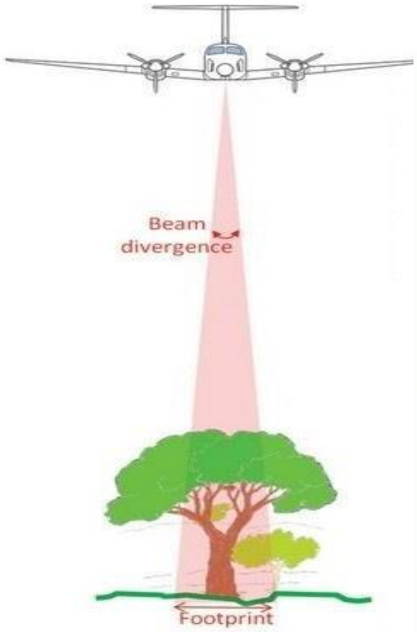
- ✓ Measures the distance from the aircraft to the ground.
- ✓ Accomplished by transmitting radio frequency energy to the

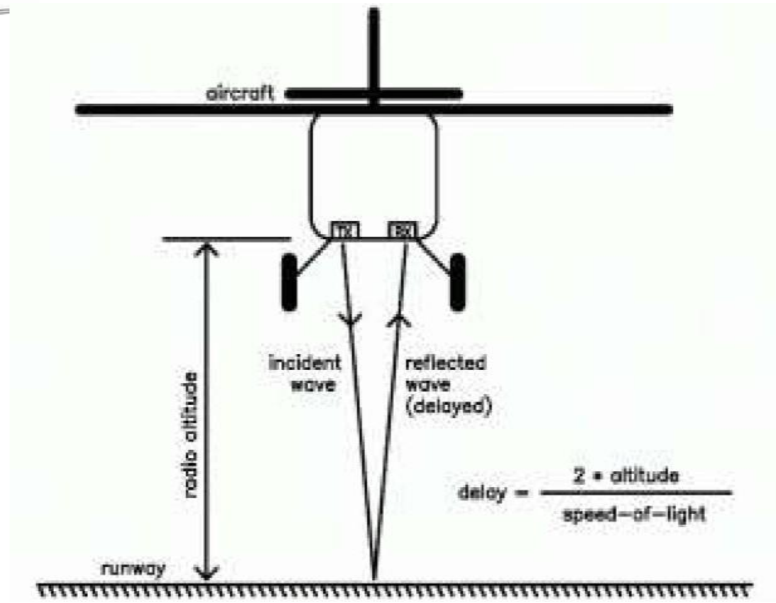
ground and receiving the reflected energy at the aircraft.

Pulse Type

- Altitude determined by measuring time required for transmitted pulse to hit ground and return.
- Indicating instrument gives true altitude of aircraft
- Used during landing to determine decision whether to continue

to land or execute climb-out





2. The delay is calculated by the following equation ;

Delay = 2x altitude / speed of light = 5km/ 3x100 000000 m/sec= 0.000016 sec= 16 μsec

Q16 .

1. What are the differences between UAV Vs Drone ?

UAV Vs Drone

- **UAV**
- IT COMPRISES OF A NUMBER OF SUBSYSTEMS WHICH INCLUDE THE AIRCRAFT (UAV), ITS PAYLOADS, CONTROL STATION(S), LAUNCH AND RECOVERY SUBSTATIONS, COMMUNICATION SUBSYSTEMS ETC.
- SYSTEM IS DESIGNED FROM ITS CONCEPTION TO BE OPERATED WITHOUT AIRCREW.
- A UAV HAS SOME DEGREE OF “AUTOMATIC INTELLIGENCE”.
- IT IS ABLE TO COMMUNICATE WITH ITS CONTROLLER AND RETURN PAYLOAD DATA ALONG WITH ITS PRIMARY STATE INFORMATION-AIRSPEED, POSITION, HEADING, ALTITUDE AND MOST IMPORTANTLY, HOUSEKEEPING INFORMATION.

- **DRONE**
- STANDS FOR DYNAMIC REMOTELY OPERATED NAVIGATION EQUIPMENT
- A DRONE IS REQUIRED TO FLY OUT OF SIGHT OF THE OPERATOR, BUT HAS ZERO INTELLIGENCE.
- IT IS MERELY LAUNCHED INTO A PRE-PROGRAMMED MISSION ON A PRE-PROGRAMMED COURSE WITH AN RTL COMMAND.
- IT DOES NOT COMMUNICATE AND THE RESULTS OF THE MISSION ARE USUALLY OBTAINED UNTIL ITS RECOVERED BACK.

2.Draw and explain the main parts of the UAV and explain the payloads of the UAV ?

PAYLOADS OF UAV

- **SENSORS:-**
- OPTICAL SENSORS
- EOIR SENSORS
- COLOR THERMAL IMAGER
- LIDAR
- SAR

- **ANTENNAS:-**
- DIRECTIONAL
- OMNIDIRECTIONAL
- FOLLOW ME OPTION USING GPS

- AUTOPILOT
- GIMBAL CONTROLLED CAMERA

Q17 . What are the communication systems used UAV and show the frequency band for each one ?

COMMUNICATION SYSTEM USED IN UAV

- **THERE ARE VARIOUS TYPES OF COMMUNICATION SYSTEMS BEING USED FOR OPERATION OF UAV'S SUCH AS**

❑ TELE COMMAND

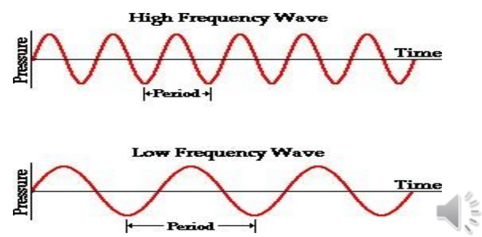
❑ TELEMETRY (2.3GHZ)

❑ TELEVISION (5.8GHZ)

❑ SATCOM

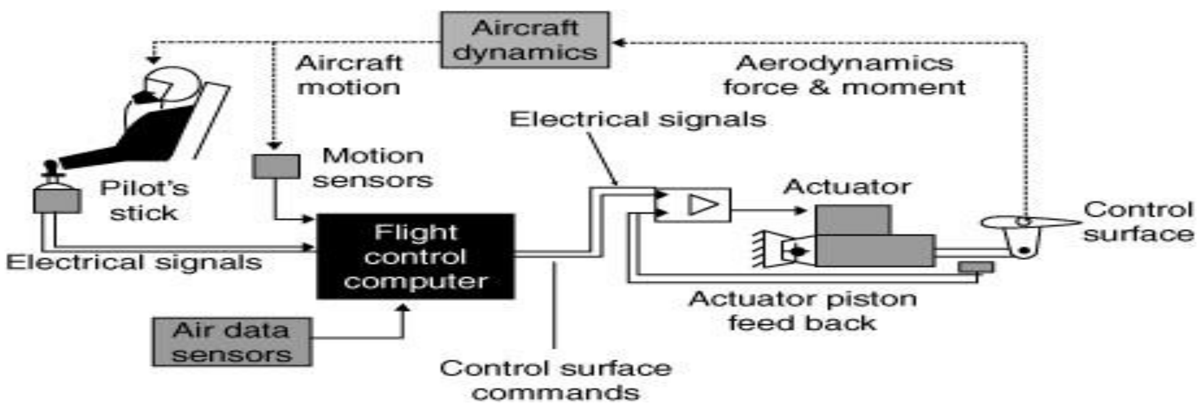
FOR A/V SIGNALS, THE FREQUENCY RANGE IS-

- 433MHZ-900MHZ (LOW FREQUENCY, AUDIO SIGNALS)
- 1.2-5.8GHZ (HIGH FREQUENCY, LIVE FEED VIDEOS)



Q18 . Design the block diagram of the flowchart of a typical FBW and explain the operation ?

FLOWCHART OF A TYPICAL FBW DESIGN



INTRODUCTION

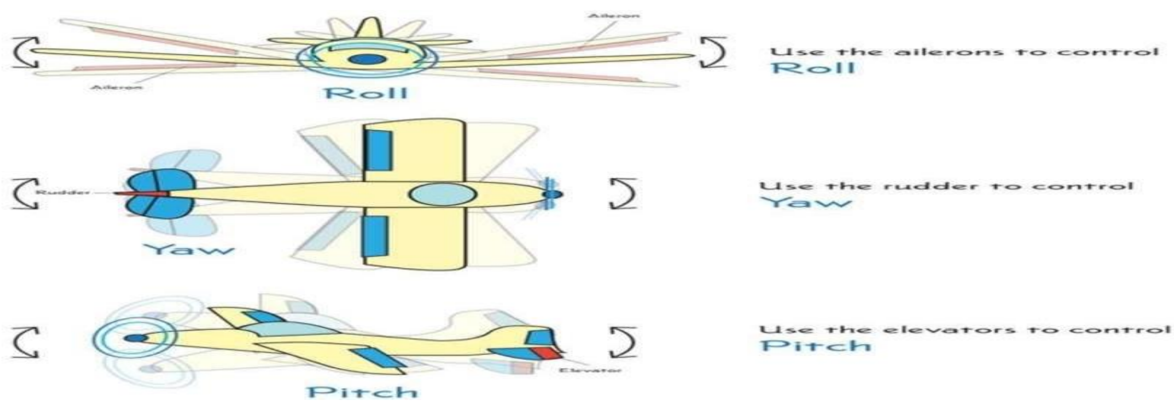
- **"Fly-by-wire" implies a purely electrically-signaled control system.**
- **Used in the general sense of computer-configured controls.**
- **Computer system interposed between the operator and the final control actuators.**
- **Manual inputs of the pilot modified in accordance with control parameters.**

ELECTRONICS IN FBW

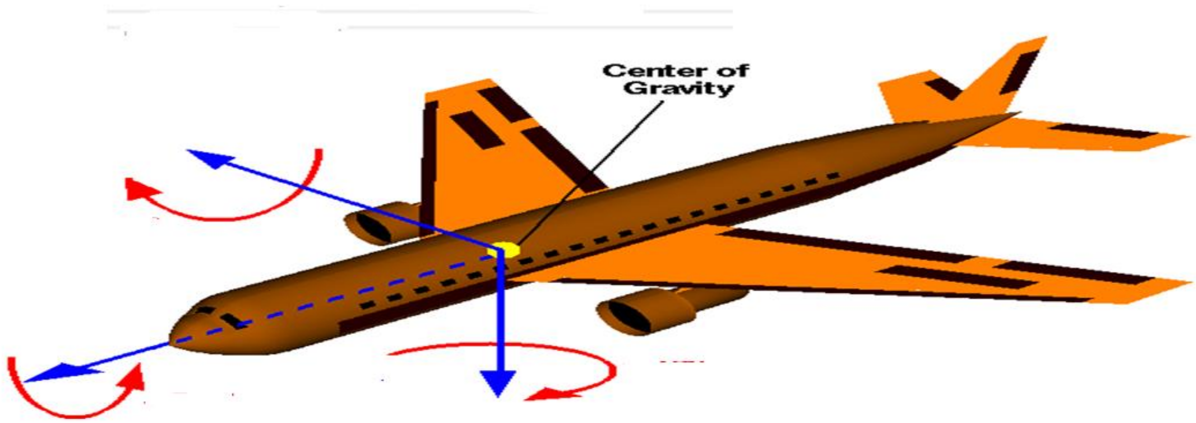
- Microcontroller becoming very popular.
- Basically Arduino based ATmega microcontroller are used in aircrafts.
- Advantage – Fast response, inbuilt ADC, reprogramming etc.
- Example Arduino Atmel ATmega328P microprocessor.

Q19 .

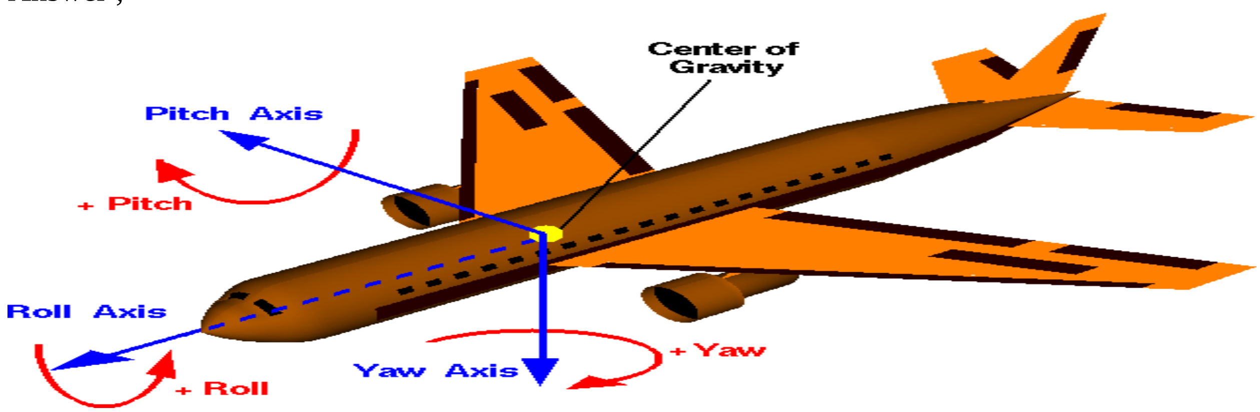
1. Define the followings with drawings the roll, pitch, yaw of the aircraft motion .



2. Figure 1, shows the Aircraft motion involves controlling roll, pitch, yaw. Assign the roll, pitch, yaw motion axis and direction of motion .

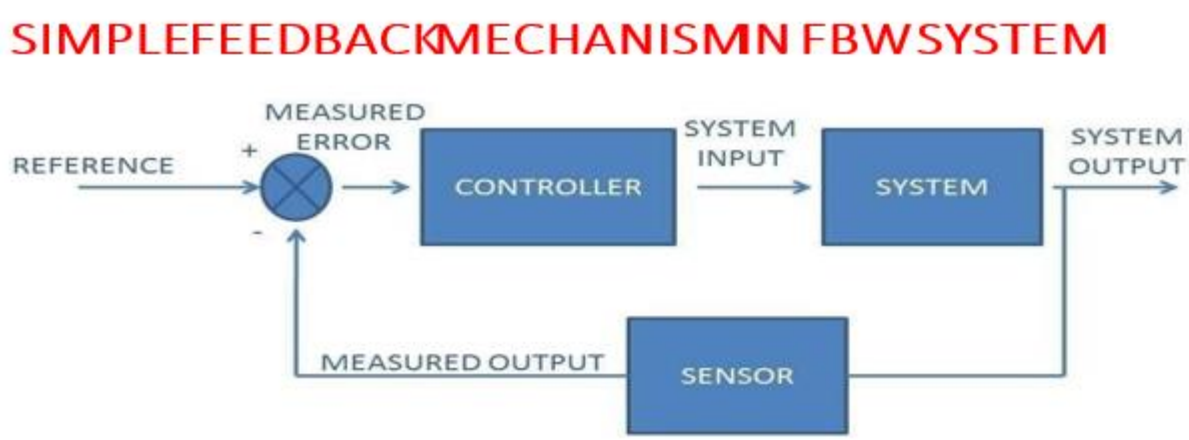


Answer ;



Q20 .

1. Design and explain the block diagram of the simple feedback mechanism in FBW system.



2. What are the types of the FBW systems and explain them briefly and show the differences between them ?

- Analog systems
- Replace hydromechanical or electromechanical control systems
with electronic circuits.
- Control system in cockpit operate signal transducers, to generate the
appropriate electronic commands.
- Signalsare then processed by an electronic controller with an analog signal.

- Digital systems
- A digital FBW control system similar to its analogcounterpart.
- Pilot literally can "fly-via-computer“.
- Increases the flexibility of the flight control system.
- Multiple redundancy techniques.
- Increase electronic stability, as system is less dependent on the value

COMPARISONAnalogVs Digital

ANALOG SYSTEMS	DIGITAL SYSTEMS
Accuracy low.	Accuracy high.
Circuit complication	Circuit is simplified.
Calibration is tough.	Calibration is easy.

Q21. Draw and explain the block diagram of the Gyro and accelerometer operation ?

Figures 5.2 and 5.3 show the 'Gyro Chip' vibrating quartz tuning fork rate gyro developed by the BEI Systron Donner Inertial Division; the author is indebted to the company for permission to publish this information.

The basic configuration is shown schematically in Figure 5.2 and comprises a vibrating quartz tuning fork to sense angular rate which is coupled to a similar fork as a pick-up to produce the rate output signal.

The piezo-electric drive tines are driven by an oscillator to vibrate at a precise amplitude. An applied rotation rate about an axis parallel to the vibrating tines causes a sine wave of torque to be produced resulting from the Coriolis acceleration as explained earlier. This oscillatory torque in turn causes the tines of the Pick-up Fork to move up and down in and out of the plane of the fork assembly. This causes an electrical output signal to be produced by the Pick-up Amplifier which is amplified and phase sensitive rectified to provide a DC signal which is directly proportional to the input rate. (The sign of the DC output signal changes sign when the input rate reverses due to the action of the phase sensitive rectifier.)

The pair of tuning forks and their support flexures and frames are batch fabricated from thin wafers of single crystal piezo-electric quartz and are micro-machined us-

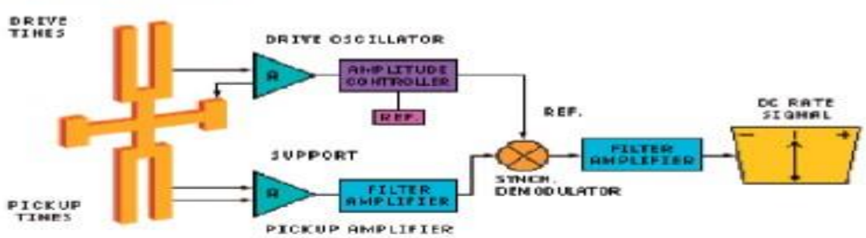


Fig. 5.2 Quartz rate sensor (courtesy of Systron Donner Inertial Division).

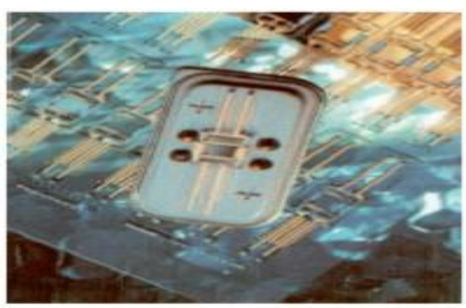


Fig. 5.3 Quartz rate sensor fabrication wafer with device overlaid (courtesy of Systron Donner Inertial Division).

Q22. Design and explain the Auto pilot of UAV (ardupilot) and its features with drawings ?

Answer :

Auto pilot of UAV(ardupilot)

- **ArduPilot** (also **ArduPilotMega**- APM) is an open source unmanned aerial vehicle (UAV) platform, able to control autonomous multicopters, fixed-wing aircraft, traditional helicopters and ground rovers.
- The system was improved to replace thermopiles with an Inertial Measurement Unit (IMU) using a combination of accelerometers, gyroscopes and magnetometers.

https://www.sparkfun.com/products/retired/9710

❖ Features of Ardupilot:-

- Programmable 3D way points
- Return to launch
- inflight reset
- fully programmable actions at waypoints
- Stabilization options to negate the need for a third party co-pilot
- Fly By Wire mode
- Optimization of 3 or 4 channel airplanes.
- Flight Simulations

Q23. Define the following with help of drawings ;

Aircraft flight control systems , Spoilers

, Rudder , Flight control, Dead Reckoning system, Arinc429, Ailerons, Instrumental Flight Rules (IFR) , VHF OMNIRANGE SYSTEM (VOR), INSTRUMENT LANDING SYSTEM (ILS), Head up display.

Answer :

Aircraft flight control systems consist of flight control surfaces, the respective cockpit controls, connecting linkages, and the necessary operating mechanisms to control an aircraft's direction in flight. Aircraft engine controls are also considered as flight controls as they change speed. They can be divided into three main groups:

- Primary flight control
- Secondary flight control

- Auxilliary flight control

Spoilers

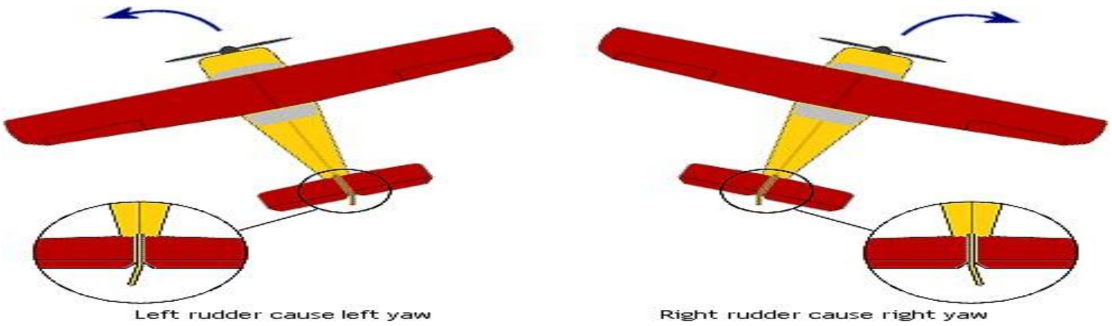
- On low drag aircraft like sailplanes, spoilers are used to disrupt airflow over the wing and greatly increase

the amount of drag.

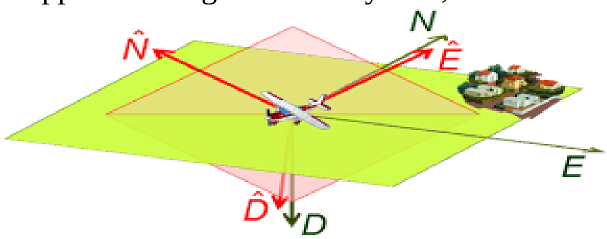
- This allows a glider pilot to lose altitude without gaining excessive airspeed.
- Spoilers are sometimes called "lift dumpers". Spoilers that can be used asymmetrically are called spoilerons and are able to affect an aircraft's roll.

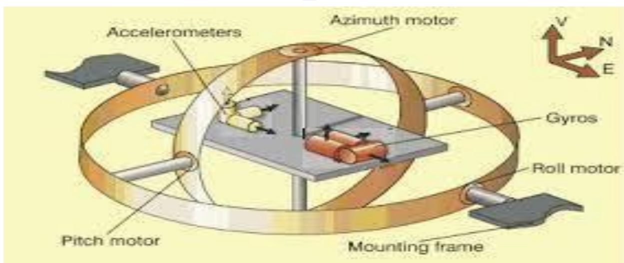
Rudder - Located at the end of the Empennage (tail)

It rotates to help the plane turn. The way it works is when the Rudder turns to the left, the plane goes left, and if the Rudder turns to the right, the plane goes right.



Flight control: Auto stabilization/ Stability Augmentation. FBW flight control systems Auto stabilization systems are required for achieving acceptable control and handling motion characteristics across flight envelope. FBW flight control systems provide continuous automatic stabilization of the aircraft by computer control of the control surfaces from appropriate motion sensors

- Dead Reckoning system: DR navigation derives the vehicles present position by estimating the distance traveled from a known position's speed and direction of motion of vehicle. They are of 3 types
  - ✓ Inertial navigation systems
  - ✓ Doppler/heading reference system,
  - ✓ 

  - ✓ 

Arinc429: ARINC 429 is a single-source, multiple-sink, half-duplex bus that operates at two transmission rates; most commonly the higher rate of 100 Kbit/s is used. Although the data

bus has its origins in the civil marketplace, it is also used extensively on civil platforms that have been adopted for military use, such as the Boeing 737, Boeing 767 and A330. High-

performance business jets such as the Bombardier Global Express and Gulfstream GV that

are frequently modified as electronic intelligence (ELINT) or reconnaissance platforms also employ A429

b. History: The ARINC 429 Specification developed out of the original commercial aviation

digital communication spec, the ARINC 419 Specification. The ARINC 419, first released in

1966 and last revised in 1983, describes four different wiring topologies, including a serial, twisted shielded pair interface used by the Digital Air Data System (DADS), known as the ARINC 575 or DADS 575 Spec.

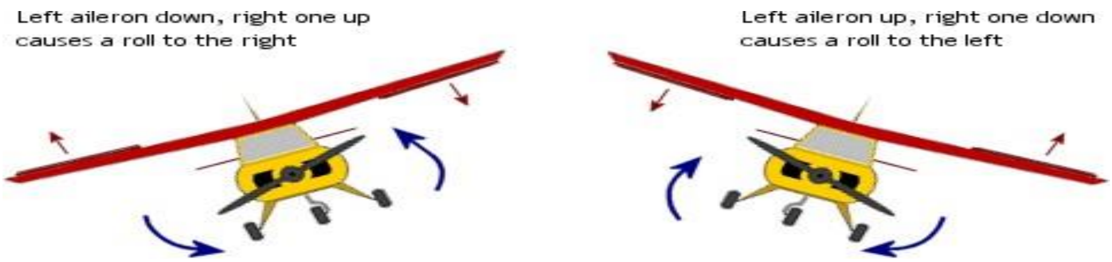
Aileron assist the plane in turning. It's located on the far end of the wings.

The purpose of the Ailerons is to roll the plane, which helps it turn.

- They are much smaller than the wind flaps. When the Aileron on wing side goes up, the other wing's Aileron goes down.

- The wing with the Aileron up tilts down, and the other Aileron which is

down, makes the wing go up.



Instrumental Flight Rules (IFR)

IFR may be described as bad weather or blind weather, when visibility is poor or the height of the clouds falls below the visual meteorological conditions. In IFR conditions, ATC personnel guide the safe separation between aircrafts.

To avoid possibility of mid air collision at high speeds and density of traffic, IFR are described regardless of the weather conditions. This is called "positive control airspace" which is used where high speed jet operate at Airport Radar Service Area (ARSA) as well as the airspace at above 6000 m above MSL, in which jet fly from one airport to another airport.

- ✓ VOR, short for VHF omnidirectional radio range, is a type of radio navigation system for aircraft, enabling them to find their position and stay on course by receiving radio signals emitted by a network of radio beacons. It uses frequencies in very high frequency (VHF) from 108 to 117.95 MHz.

INSTRUMENT LANDING SYSTEM (ILS)

- ✓ It Operates in the VHF portion of the electromagnetic spectrum
- ✓ System consists of a runaway localizer, a glide slope signal, and marker beacons for position location
- ✓ Localizer equipment produces a radio course aligned with the centre of an airport runaway. The on course signals result from the equal reception of two signals; Blue sector(150 Hz) and yellow sector(90 Hz)
- ✓ In aviation, the instrument landing system (ILS) is a radio navigation system that provides short-range guidance to aircraft to allow them to approach a runway at night or in bad weather.

Head up display

- A head-up display,[1] also known as a HUD (/hʌd/), is any transparent display that presents data without requiring users to look away from their usual viewpoints. The origin of the name stems from a pilot being able to view information with the head positioned "up" and looking forward, instead of angled down looking at lower instruments. A HUD also has the advantage that the pilot's eyes do not need to refocus to view the outside after looking at the optically nearer instruments.

Q24 .

1. What are the main cockpit display systems

Answer :

The main cockpit display systems

- Primary display
- Head Up Display
- Helmet mounted display
- Head down display
- Multi function display

2. Design and explain the Primary Flight Display showing the marker of the following parameters ;

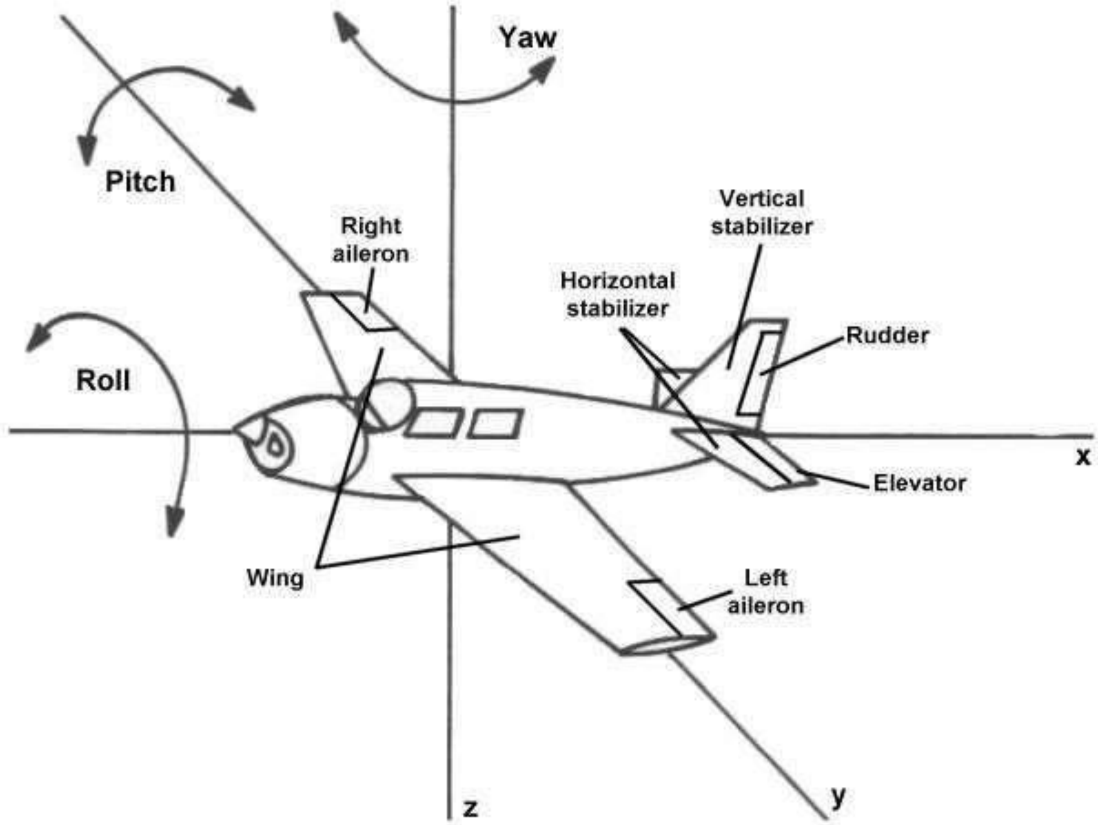
Altitude indicator, slip/skid indicator, air speed indicator, turn indicator, vertical speed indicator, altimeter, horizontal stabilization indicator, .

- A PFD presents information about primary flight instruments, navigation instruments, and the status of the flight in one integrated display. Some systems include powerplant information and other systems information in the same display. A typical primary flight display is shown in Figure

Q25. Draw the 3D dimension Movement of an Aircraft showing the following parameters directions ;

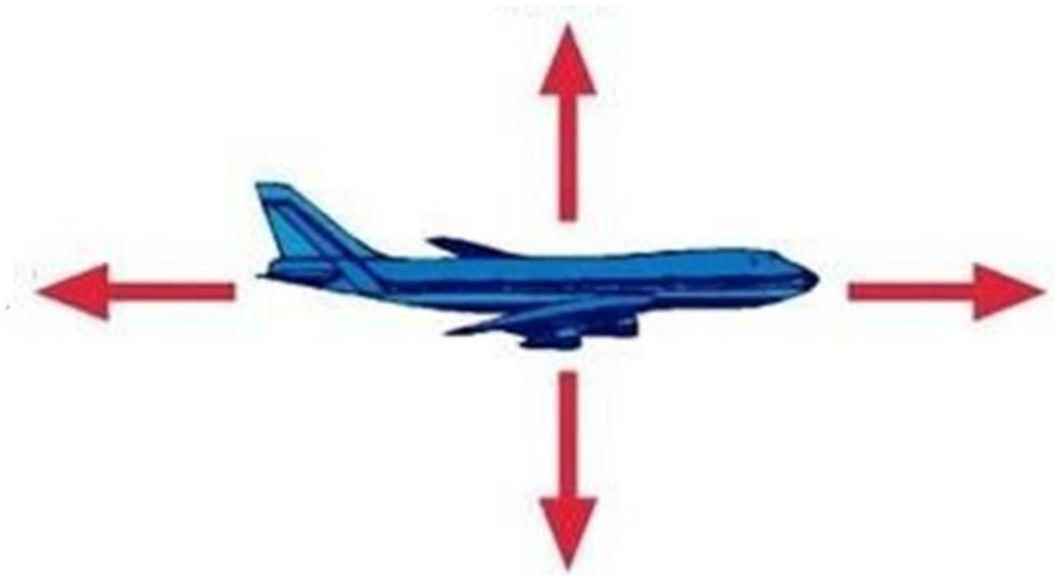
Roll, Pitch, Yaw, Right aileron, Wing, Vertical stabilizer, horizontal stabilizer, Rudder, Elevator, Left aileron.

Answer ; figure 1, shows the directions of movement of the Roll, Pitch, Yaw, Right aileron, Wing, Vertical stabilizer, horizontal stabilizer, Rudder, Elevator, Left aileron.



Q26 . Figure 1, shows an aircraft structure , assign the following forces on suitable red arrow and explain the function of each one ;

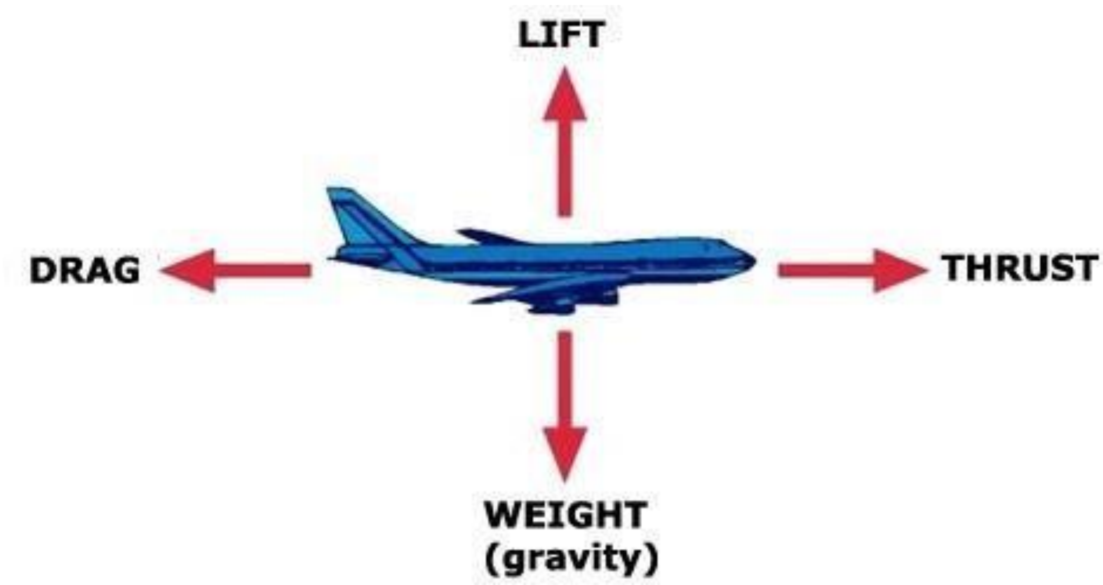
Lift, Thrust, Weight, and Drag.



Answer :

Each force has an opposite force that works against it. Lift works opposite of weight. Thrust works opposite of drag. When the forces are balanced, a plane flies in a level direction. The plane goes up if the forces of lift and thrust are more than gravity and drag.

- Drag: the force that acts in the opposite direction of the plane and slows the plane down
- Lift: the upward force that allows an airplane to stay in the air
- Thrust: the forward force that propels the plane forward
- Weight: the downward force of gravity that pulls the plane toward the ground



Q27 . Design and explain the Air Traffic Control Radar system and explain its operation .

Air traffic control (ATC) is a service provided by ground-based air traffic controllers (also called control tower operators (CTO)) who direct aircraft on the ground and through a given section of controlled airspace, and can provide advisory services to aircraft in non-controlled airspace. The primary purpose of ATC worldwide is to prevent collisions, organize and expedite the flow of air traffic, and provide information and other support for pilots.

Model Description

To make parameters for *Radar System Design* easier to change and easier to determine their values, the model has a GUI. Radar and weather parameters may be changed from this GUI. While simulating, the effects of these parameters can be seen on the scope display which shows the actual aircraft range in yellow and the estimated aircraft range from the radar in magenta. Another output that can be viewed is the calculated signal to noise ratio (SNR) is compared to the ideal SNR. Ideal SNR is also specified from the GUI. The result is shown in the display block and will be either 1 (SNR >= ideal SNR) or 0 (SNR < ideal SNR).