Gleim Private Pilot Flight Maneuvers

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Appendix C: Basic Flight Maneuvers

Page 653, add Appendix C: For increased knowledge base and for use with the Gleim *Private Pilot Syllabus*, an Appendix C is being added to the book. The new appendix in its entirety is provided for you on the following pages.

APPENDIX C
BASIC FLIGHT MANEUVERS

During your first few flight lessons, your instructor will introduce you to the basic flight maneuvers, i.e., straight-and-level flight, turns, climbs, and descents. While these maneuvers are not specifically listed as tasks in the FAA's Airman Certification Standards, they are the fundamentals of flying. Every maneuver you will do is either one or a combination of the basic flight maneuvers.

Always look for other aircraft. See Study Unit 3, "Airports, Air Traffic Control, and Airspace," in *Pilot Handbook* for a discussion on collision avoidance procedures. Clearing turns are usually two 90° turns in opposite directions (e.g., a 90° turn to the left, then a 90° turn to the right) or a 180° turn with the purpose of complete and careful vigilance for other traffic.

In some of the study units that discuss ACS tasks, we present a list of common errors for each flight maneuver. While you are just getting started, you should focus on how to do these basic flight maneuvers. We do not want to confuse or burden you with what might go wrong. Your flight instructor will diagnose any improper technique.

INTEGRATED FLIGHT TRAINING

A. The FAA recommends integrated flight training, which means that each flight maneuver (except those requiring ground references) should be learned first by outside visual references and then by instrument references only (i.e., flight instruments).

   1. Thus, instruction in the control of the airplane by outside visual references is **integrated** with instruction in the use of flight instrument indications for the same operations.
   2. Integrated instruction will assist you in developing a habit of monitoring your flight and engine instruments.
      a. You should be able to hold desired altitudes, control airspeed during various phases of flight, and maintain headings.

AERODYNAMIC FACTORS

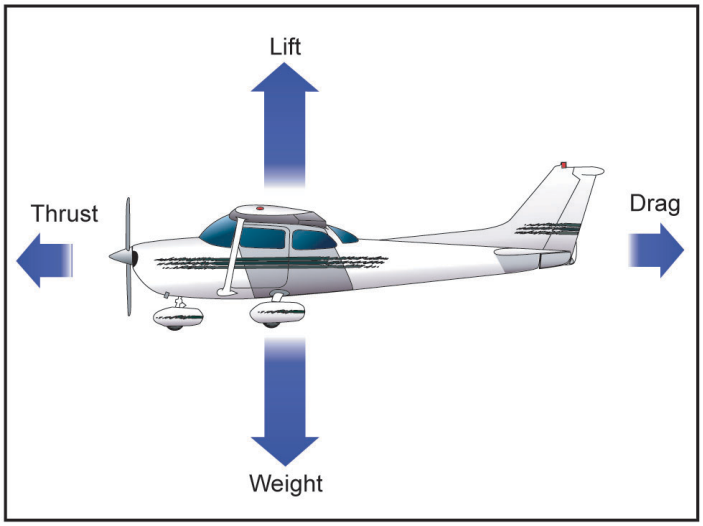
A. Among the aerodynamic forces acting on an airplane during flight, four are considered to be basic because they act upon the airplane during all maneuvers. These basic forces in relation to straight-and-level, unaccelerated flight are

   1. **Lift** -- the upward-acting force that opposes weight. Lift is produced by the dynamic effect of the air acting on the wing and acts perpendicular to the flight path through the wing's center of lift.
   2. **Weight** -- the combined load of the airplane itself, the crew, the fuel, and the cargo or baggage. Weight pulls the airplane downward toward the center of the Earth because of the force of gravity. It opposes lift and acts vertically downward through the airplane's center of gravity.

3. **Thrust** -- the forward force produced by the engine/propeller. Thrust opposes or overcomes the force of drag. As a general rule, it is said to act parallel to the longitudinal axis.
4. **Drag** -- the rearward, retarding force that is caused by disruption of airflow by the wing, fuselage, and other protruding objects. Drag opposes thrust and acts rearward and parallel to the relative wind.

B. While in steady (unaccelerated) flight, the attitude, direction, and speed of the airplane will remain constant until one or more of the basic forces change in magnitude.

1. In steady flight, the opposing forces are in equilibrium.
   a. That is, the sum of all upward forces (not just lift) equals the sum of all downward forces (not just weight), and the sum of all forward forces (not just thrust) equals the sum of all rearward forces (not just drag).



STRAIGHT-AND-LEVEL FLIGHT

A. Straight-and-level flight simply means that a constant heading and altitude are maintained.

1. It is accomplished by making corrections for deviations in direction and altitude from unintentional turns, descents, and climbs.

B. The pitch attitude for **level flight** (i.e., constant altitude) is obtained by selecting some portion of the airplane's nose or instrument glare shield as a reference point and then keeping that point in a fixed position relative to the horizon.

1. That position should be cross-checked occasionally against the altimeter to determine whether or not the pitch attitude is correct for the power setting being used.
   a. If altitude is being lost or gained, the pitch attitude should be readjusted in relation to the horizon, and then the altimeter should be checked to determine if altitude is being maintained.
2. The application of forward or back elevator pressure is used to control this attitude.
   a. The term "increasing the pitch attitude" implies raising the nose in relation to the horizon by pulling back on the control yoke.
   b. The term "decreasing the pitch" means lowering the nose by pushing forward on the control yoke.
3. The pitch information obtained from the attitude indicator will also show the position of the nose relative to the horizon.

C. To achieve **straight flight** (i.e., constant heading), you should select two or more outside visual reference points directly ahead of the airplane (e.g., roads, section lines, towns, lakes, etc.) to form an imaginary line and then keep the airplane headed along that line.
    1. While using these references, you should occasionally check the heading indicator (HI) to determine that the airplane is maintaining a constant heading.
    2. Both wingtips should be equidistant above or below the horizon (depending on whether your airplane is a high-wing or low-wing type). Any necessary adjustment should be made with the ailerons to return to a wings level flight attitude.
        a. Observing the wingtips helps to divert your attention from the airplane's nose and expands the radius of your visual scan, which assists you in collision avoidance.
    3. The attitude indicator (AI) should be checked for small bank angles, and the heading indicator (HI) should be checked to note deviations from the desired direction.

D. Straight-and-level flight requires almost no application of control pressure if the airplane is properly trimmed and the air is smooth.
    1. Trim the airplane so it will fly straight and level without constant assistance.
        a. This is called "hands-off flight."
        b. The trim controls, when correctly used, are aids to smooth and precise flying.
        c. Improper trim technique usually results in flying that is physically tiring, particularly in prolonged straight-and-level flight.
    2. The airplane should be trimmed by first applying control pressure to establish the desired attitude, and then adjusting the trim so that the airplane will maintain that attitude without control pressure in hands-off flight.

E. The airspeed will remain constant in straight-and-level flight with a constant power setting.
    1. Significant changes in airspeed (e.g., power changes) will, of course, require considerable changes in pitch attitude to maintain altitude.
    2. Pronounced changes in pitch attitude will also be necessary as the flaps and landing gear (if retractable) are operated.

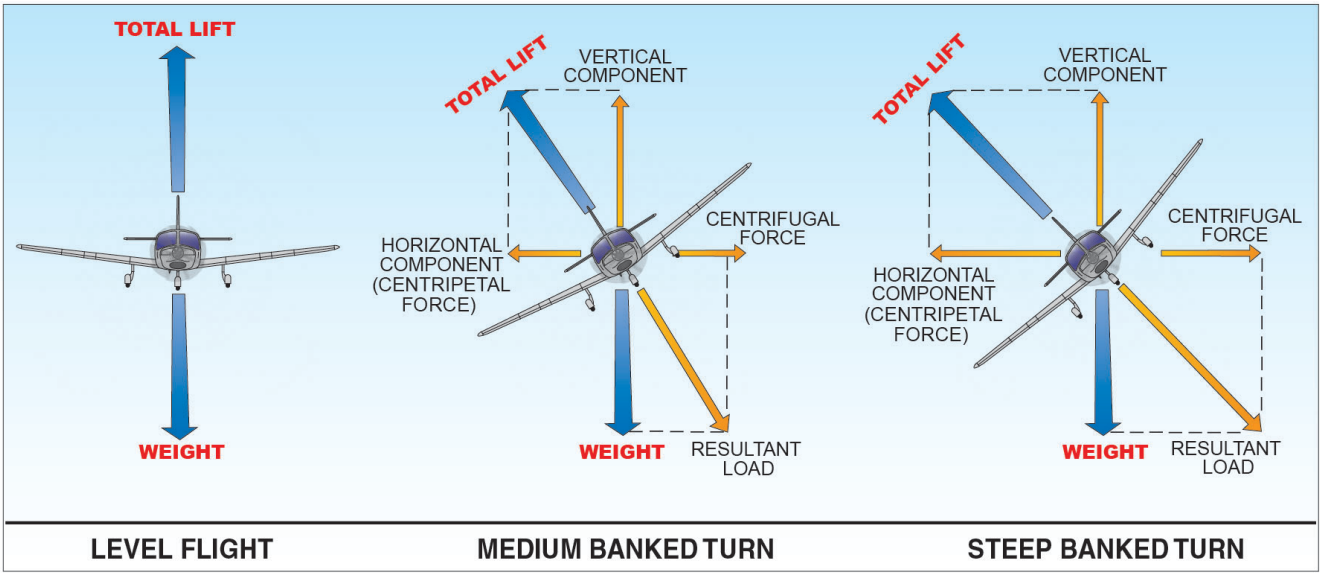
TURNS

A. A turn is a basic flight maneuver used to change from, or return to, a desired heading. This maneuver involves the coordinated use of the ailerons, rudder, and elevator.
    1. Your CFI will use the terms shallow, medium, or steep turns to indicate the approximate bank angle to use.
        a. EXAMPLE: A shallow turn uses 20° of bank, a medium turn uses 30° of bank, and a steep turn uses 45° of bank.
    2. You will begin your training by using shallow to medium banked turns.

B. To enter a turn, you should simultaneously turn the control wheel (i.e., apply aileron control pressure) and rudder pressure in the desired direction.
    1. The speed (or rate) at which your airplane rolls into a bank depends on the rate and amount of control pressure you apply.
        a. The amount of bank depends on how long you keep the ailerons deflected.
    2. Rudder pressure must be enough to keep the ball of the inclinometer (part of the turn coordinator) centered.
        a. If the ball is not centered, step on the ball to recenter.
        b. EXAMPLE: If the ball is to the right, apply right rudder pressure (i.e., step on the ball) to recenter.

3. The best outside reference for establishing the degree of bank is the angle made by the top of the engine cowling or the instrument panel with respect to the horizon.
   a. Since the engine cowling is fairly flat on most light airplanes, its horizontal angle to the horizon will give some indication of the approximate degree of bank.
   b. Your posture while seated in the airplane is very important in all maneuvers, particularly during turns, since that will affect the alignment of outside visual references.
      1) At first, you may want to lean away from the turn in an attempt to remain upright in relation to the ground instead of rolling with the airplane.
      2) You must overcome this tendency and learn to ride with your airplane.
   c. In an airplane with side-by-side seating, you will be seated in the left seat. Since your seat is to the left of the centerline of the airplane, you will notice that to maintain altitude the nose position will be different on turns to the left than to the right.
      1) In a turn to the left, the nose may appear level or slightly high.
      2) In a turn to the right, the nose will appear to be low.
4. Information obtained from the attitude indicator (AI) will show the angle of the wings in relation to the horizon. This information will help you learn to judge the degree of bank based on outside references.

C. The lift produced by the wings is used to turn the airplane. When you bank the airplane, the lift is separated into two components known as the vertical and the horizontal components of lift, as shown below.



1. The horizontal component of lift creates a force that is directed inward toward the center of the airplane's rotation. This force, known as centripetal force, causes the airplane to turn.
   a. The steeper the bank, the sharper the turn due to the increase in the horizontal lift.
2. In a bank, the total lift consists of both horizontal lift (to turn the airplane) and vertical lift (counteracting weight/gravity).
   a. Given the same amount of total lift, there is less vertical lift in a bank than in straight-and-level flight.

b. To maintain altitude, the vertical lift must remain equal to weight. Thus, total lift must be increased.

1) Total lift is increased by applying enough back elevator pressure (i.e., increasing the angle of attack) to maintain altitude.

2) This increase in pitch will cause a slight decrease in airspeed. In a medium banked turn, this slight decrease in airspeed is acceptable and will be regained once the wings are level, so no increase in power is required.

D. As the desired angle of bank is established, aileron and rudder pressures should be released. The bank will not continue to increase since the aileron control surfaces will be neutral in their streamlined position.

1. The back elevator pressure should not be released but should be held constant or sometimes increased to maintain a constant altitude.

2. Throughout the turn, you should cross-check the references and occasionally include the altimeter to determine whether the pitch attitude is correct.

3. If gaining or losing altitude, adjust the pitch attitude in relation to the horizon, and then recheck the altimeter and vertical speed indicator to determine if altitude is now being maintained.

E. The rollout from a turn is similar to the roll-in except that control pressures are used in the opposite direction. Aileron and rudder pressures are applied in the direction of the rollout or toward the high wing.

1. Since the airplane will continue turning as long as there is any bank, the rollout must be started before reaching the desired heading.

a. The time to begin rollout in order to lead the heading will depend on the rate of turn and the rate at which the rollout will be made.

b. Lead your rollout by an amount equal to one-half your bank angle.

1) If you are using a 30° bank, begin your rollout approximately 15° before your desired heading.

2. As the angle of bank decreases, the elevator pressure should be released smoothly as necessary to maintain altitude. Remember, when the airplane is no longer banking, the vertical component of lift increases.

3. As the wings become level, the control pressures should be gradually and smoothly released so that the controls are neutralized as the airplane resumes straight-and-level flight.

4. As the rollout is completed, attention should be given to outside visual references as well as to the attitude indicator and heading indicator to determine that the wings are leveled precisely and the turn stopped.

CLIMBS

A. Climbs and climbing turns are basic flight maneuvers in which the pitch attitude and power result in a gain in altitude. In a straight climb, the airplane gains altitude while traveling straight ahead. In climbing turns, the airplane gains altitude while turning.

B. Your CFI will introduce you to various climb airspeeds early in your flight training.

1. **Best rate of climb (V_Y)** provides the greatest gain in altitude in the least amount of time.

2. **Best angle of climb (V_X)** provides the greatest gain in altitude in a given distance.

3. **Cruise climb** is used to climb to your desired altitude. This speed provides better engine cooling and forward visibility.

4. These airspeeds are listed in your Pilot's Operating Handbook (POH) and/or Airplane Flight Manual (AFM).

C. To enter the climb, simultaneously advance the throttle and apply back elevator pressure.
    1. As the power is increased to the climb setting, the airplane's nose will tend to rise to the climb attitude.
        a. In most trainer-type airplanes, the climb setting will be full power. Check your POH/AFM for information.
    2. While the pitch attitude increases and airspeed decreases, progressively more right-rudder pressure must be used to compensate for torque effects and to maintain direction.
        a. Since the angle of attack is relatively high, the airspeed is relatively slow, and the power setting is high, the airplane will have a tendency to roll and yaw to the left.
            1) While right-rudder pressure will correct for the yaw, some aileron pressure may be required to keep the wings level.
        b. See Study Unit 1, "Airplanes and Aerodynamics," in *Pilot Handbook* for a discussion on torque (left-turning tendency).

D. When the climb is established, back elevator pressure must be maintained to keep the pitch attitude constant.
    1. As the airspeed decreases, the elevators may try to return to their streamline or neutral position, which will cause the nose to lower.
        a. Nose-up trim will be required.
    2. Since you want to climb at a specific airspeed, you will need to cross-check the airspeed indicator (ASI), which will also provide you with an indirect indication of pitch attitude.
        a. If the airspeed is higher than desired, you need to use the outside references and attitude indicator to raise the nose.
        b. If the airspeed is lower than desired, you need to use the outside references and attitude indicator to lower the nose.
    3. After the climbing attitude, power setting, and airspeed have been established, trim the airplane to relieve all pressures from the controls.
        a. If further adjustments are made in pitch, power, and/or airspeed, you must retrim the airplane.
    4. If a straight climb is being performed, you need to maintain a constant heading with the wings level.
        a. If a climbing turn is being performed, maintain a constant angle of bank.

E. To return to straight-and-level flight from a climbing attitude, you should lead the level-off before reaching the desired altitude.
    1. Start to level off a distance below the desired altitude equal to about 10% of the airplane's rate of climb as indicated on the vertical speed indicator.
        a. EXAMPLE: If you are climbing at 500 fpm, start to level off 50 ft. below your desired altitude.
    2. To level off, the wings should be leveled and the nose lowered.
    3. The nose must be lowered gradually, however, because a loss of altitude will result if the pitch attitude is decreased too abruptly before allowing the airspeed to increase adequately.
        a. As the nose is lowered and the wings are leveled, retrim the airplane.
        b. When the airspeed reaches the desired cruise speed, reduce the throttle setting to appropriate cruise power setting, adjust the mixture control to the manufacturer's recommended setting, and trim the airplane.

F. **Climbing turns.** The following factors should be considered:

1. With a constant power setting, the same pitch attitude and airspeed cannot be maintained in a bank as in a straight climb due to the decrease in the vertical lift and airspeed during a turn.
    a. The loss of vertical lift becomes greater as the angle of bank is increased, so shallow turns may be used to maintain an efficient rate of climb. If a medium- or steep-banked turn is used, the airplane's rate of climb will be reduced.
    b. The airplane will have a greater tendency towards nose heaviness than in a straight climb, due to the decrease in the vertical lift.
2. As in all maneuvers, attention should be diverted from the airplane's nose and divided among all references equally.
3. There are two ways to establish a climbing turn: Either establish a straight climb and then turn or establish the pitch and bank attitudes simultaneously from straight-and-level flight.
    a. The second method is usually preferred because you can more effectively check the area for other aircraft while the climb is being established.

DESCENTS

A. A descent is a basic maneuver in which the airplane loses altitude in a controlled manner. Descents can be made

1. With partial power, as used during an approach to a landing
2. Without power, i.e., as a glide
3. At cruise airspeeds, during en route descents

B. To enter a descent, you should first apply carburetor heat (if recommended in the POH/AFM) and then reduce power to the desired setting or to idle.

1. Maintain a constant altitude by applying back elevator pressure as required until the airspeed decreases to the desired descent airspeed.
2. Once the descent airspeed has been reached, lower the nose attitude to maintain that airspeed and adjust the trim.

C. When the descent is established, cross-check the airspeed indicator (ASI) to ensure that you are descending at the desired airspeed.

1. If the airspeed is higher than desired, slightly raise the nose. Allow the airspeed to stabilize to confirm the adjustment.
2. If the airspeed is lower than desired, slightly lower the nose. Allow the airspeed to stabilize to confirm the adjustment.
3. Once you are descending at the desired airspeed, note the position of the airplane's nose to the horizon and the position on the attitude indicator (AI).
    a. Trim the airplane to relieve all control pressures.
4. Maintain either straight or turning flight, as desired.

D. The level-off from a descent must be started before reaching the desired altitude.

1. Begin the level-off at a distance equal to about 10% of the airplane's rate of descent as indicated on the vertical speed indicator (VSI).
    a. EXAMPLE: If you are descending at 500 fpm, start the level-off 50 ft. above your desired altitude.

2. At the lead point, you should simultaneously raise the nose to a level attitude and increase power to the desired cruise setting.
    a. The addition of power and the increase in airspeed will tend to raise the nose. You will need to apply appropriate elevator control pressure and make a trim adjustment to relieve some of the control pressures.

E. **Turning Descents**

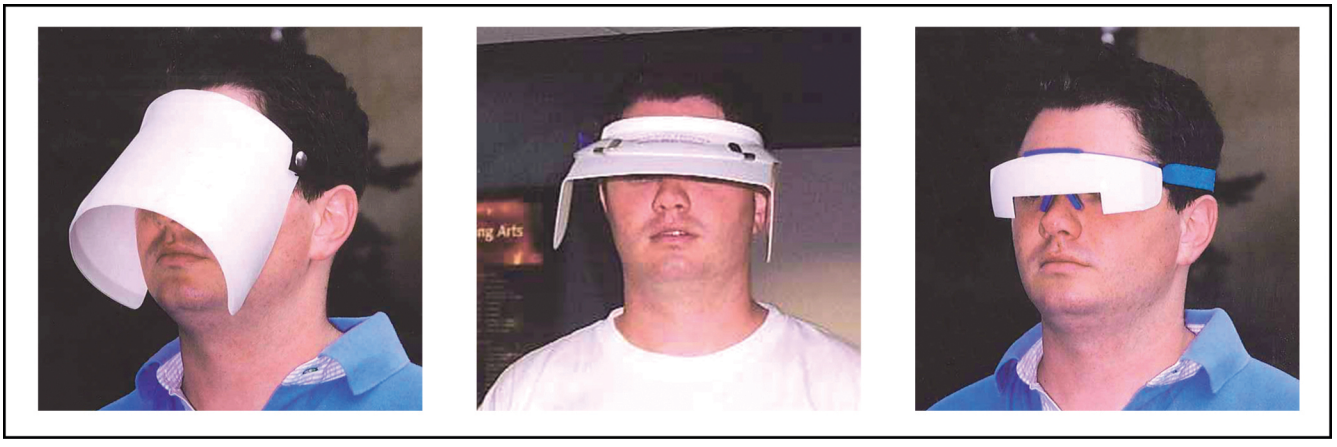
1. As with climbing turns, you can either enter the turn after the descent has been established or simultaneously adjust the bank and pitch attitudes.
2. At a desired power setting during a descending turn, maintain airspeed with pitch as you would in a straight descent.

ATTITUDE FLYING

A. As a practical matter, your initial experience (i.e., introductory flight) with the flight controls will be based on outside visual references. As your flight instructor works with you on perfecting the basic flight maneuvers, you should be prepared to fly the airplane based on the six flight instruments:

- Airspeed indicator (ASI)
- Attitude indicator (AI)
- Altimeter (ALT)
- Turn coordinator (TC)
- Heading indicator (HI)
- Vertical speed indicator (VSI)

1. Turn to Study Unit 36 and invest 15 minutes in Subunit 3, item A.1., so you learn and understand what each of the above six flight instruments looks like, what each tells you, and how you “scan” and interpret the instruments.
2. View-limiting devices. In order to learn how to fly by instrument reference only, you will use an easily removable device (e.g., a hood, an extended visor cap, or foggles) that will limit your vision to the instrument panel. There are numerous sizes and shapes available. Some of these are illustrated below.
    a. These view-limiting devices require acclimation. You should spend a few minutes in “your” airplane with “your” device on before you meet your CFI for your first flight lesson that prescribes flying by instrument reference only. This added familiarity with (1) the view-limiting device and (2) the location of the instruments and their appearance will make it easier to concentrate on flight maneuvers once in the air.



3. As you practice your flight maneuvers, your instructor will have you perform them under the hood as well as by visual reference.

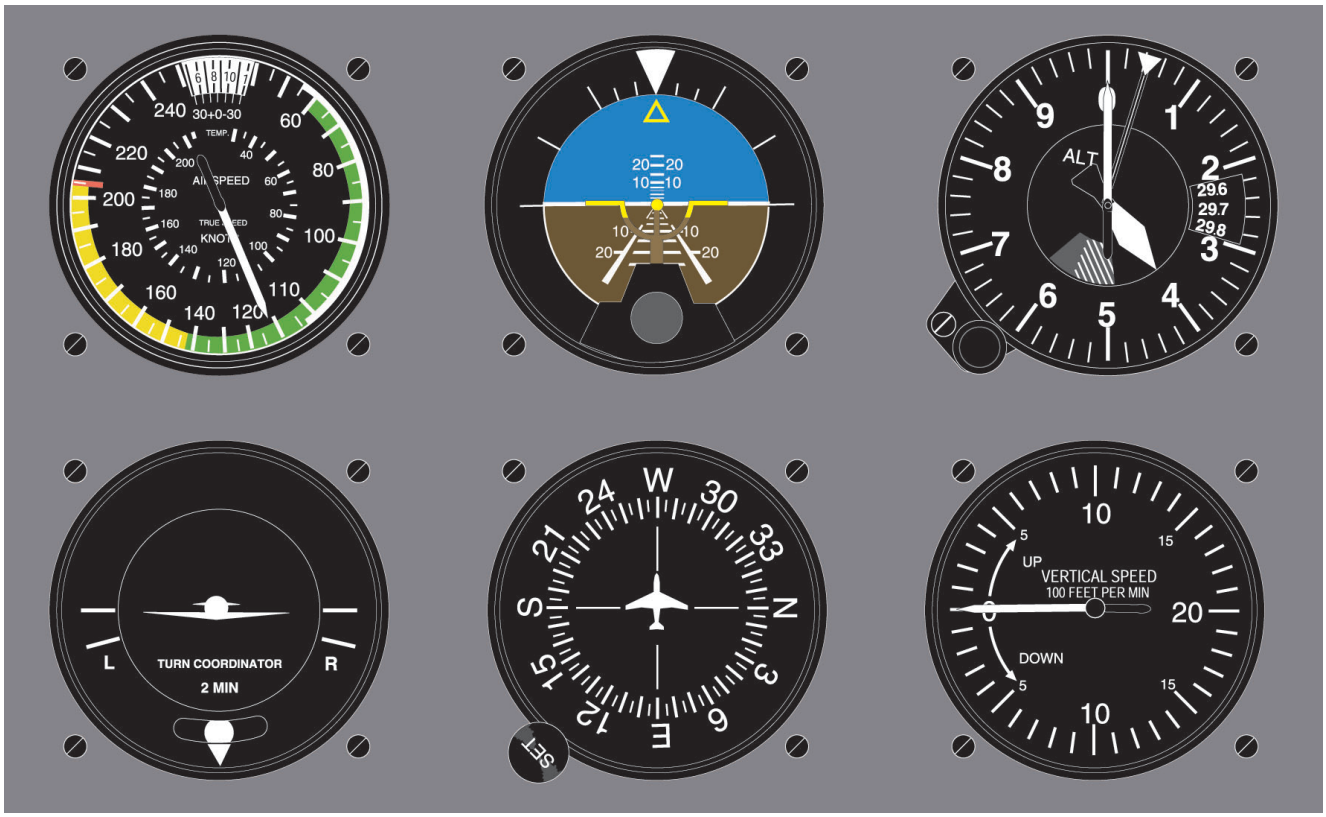
B. Airplane control is composed of four components: pitch control, bank control, power control, and trim.

1. **Pitch control** is the control of the airplane about its lateral axis (i.e., wingtip to wingtip) by applying elevator pressure to raise or lower the nose, usually in relation to the horizon.
2. **Bank control** is the control of the airplane about its longitudinal axis (i.e., nose to tail) by use of the ailerons to attain the desired angle of bank in relation to the horizon.
3. **Power control** is the control of power or thrust by use of the throttle to establish or maintain a desired airspeed, climb rate, or descent rate in coordination with the attitude changes.
4. **Trim** is used to relieve all possible control pressures held after a desired attitude has been attained.
5. For additional information on the flight controls and control surfaces, refer to the discussion/ illustration in Study Unit 1, “Airplanes and Aerodynamics,” in *Pilot Handbook*.

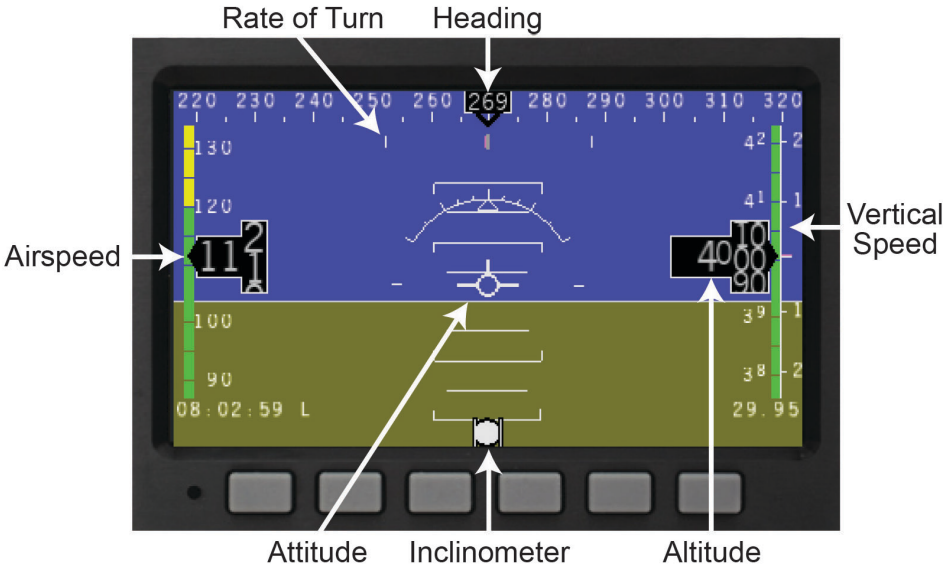
C. The outside references used in controlling the airplane include the airplane’s nose and wingtips to show both the airplane’s pitch attitude and flight direction, and the wings and frame of the windshield to show the angle of bank.

1. The instrument references will be the six basic flight instruments: attitude indicator, heading indicator, altimeter, airspeed indicator, turn coordinator, and vertical speed indicator, all typically laid out as shown below:

- ASI
- AI
- ALT
- TC
- HI
- VSI



2. If your airplane features an electronic flight information system (EFIS), you will obtain the same information in a digital display. See the following labeled example:



   a. The remainder of this text will refer to standard cockpit instrumentation. Because the same information is presented on an EFIS, you will have no problem determining what instrumentation is being referred to.
   b. Additionally, completing the Aircraft Information sheet in Study Unit 1 on page 6 and following the cockpit familiarization guidance in Appendix A on page 632 will ensure that you become comfortable interpreting flight information early in your training.

D. The objectives of these basic flight maneuvers are

1. To learn the proper use of the flight controls for maneuvering the airplane
2. To attain the proper attitude in relation to the horizon by use of visual and instrument references
3. To emphasize the importance of dividing your attention and constantly checking all reference points while looking for other traffic
4. Being able to safely fly an airplane if you ever inadvertently lose reference to the horizon