ROYAL CANADIAN AIR CADETS

PROFICIENCY LEVEL TWO

INSTRUCTIONAL GUIDE

SECTION 4

EO M231.04 – DESCRIBE THE AXIAL MOVEMENTS OF AN AIRCRAFT

Total Time: 30 min

PREPARATION

PRE-LESSON INSTRUCTIONS

Resources needed for the delivery of this lesson are listed in the lesson specification located in A-CR-CCP-802/PG-001, Chapter 4. Specific uses for said resources are identified throughout the Instructional Guide within the TP for which they are required.

Review the lesson content and become familiar with the material prior to delivering the lesson.

Create presentation slides of Figure 11K-1.

Copy the handouts located at Annexes K and L for each cadet.

Obtain a model of a light fixed-wing aircraft with wing struts, fixed gear and control surface detail.

PRE-LESSON ASSIGNMENT

N/A.

APPROACH

An interactive lecture was chosen for TP1 and TP2 to introduce the subject of axial movement and give an overview of it.

A group discussion was chosen for TP3 and TP4 as it allows the cadets to interact with their peers and share their knowledge, experiences, opinions, and feelings about axial aircraft movement.

INTRODUCTION

REVIEW

Review EO M231.01 (The Four Forces That Act Upon an Aircraft), to include:

- weight,
- drag,
- thrust,
- lift, and
- the state of equilibrium.

OBJECTIVES

By the end of this lesson the cadet shall be expected to identify the three axes of an aircraft and describe an aircraft's movement about them.

IMPORTANCE

It is important for cadets to learn about aircraft axes and axial movement so that they can understand subsequent and related principles of flight.

Teaching Point 1 **Identify the Three Axes of Aircraft Movement**

Time: 5 min Method: Interactive Lecture

Aircraft operate in a three-dimensional space so there are three corresponding ways they can turn. Each of the three possibilities has an associated axis of motion:

- the longitudinal axis,
- the lateral axis, and
- the vertical axis.

Show the cadets a slide or distribute handouts of aircraft axes in Figure 11K-1.

When an aircraft is airborne, it can move in almost any direction. All movement of the aircraft takes place around the centre of gravity. This is the aircraft's balance point, or point through which all weight acts downwards.

The centre of gravity is the point where the three axes intersect.

To clarify the ways that aircraft can move in flight, the aircraft is said to move around an axis. This is an imaginary line running through the centre of gravity of the aircraft and around which the aircraft rotates.

There are three such axes and the aircraft may rotate around one, two or all three axes at the same time. They are the longitudinal axis, the lateral axis, and the vertical axis:

- The longitudinal axis runs lengthwise through the fuselage from the nose to the tail and passes through the centre of gravity.
- The lateral axis runs from wingtip to wingtip through the centre of gravity.
- The vertical axis runs vertically through the centre of gravity. It is situated at right angles to the other axes.

CONFIRMATION OF TEACHING POINT 1

QUESTIONS

Q1. Why does an aircraft have exactly three axes of motion?

Q2. Where is an aircraft's centre of gravity located?

Q3. What are the three axes of an aircraft called?

ANTICIPATED ANSWERS

A1. An aircraft operates in a three-dimensional space and needs an axis for each dimension.

A2. At the intersection of the three axes of motion.

A3. The three axes of an aircraft are the longitudinal axis, the lateral axis and the vertical axis.

Teaching Point 2 **Describe the Three Axial Movements That Aircraft Make**

Time: 10 min Method: Interactive Lecture

Using a model aircraft, describe the three movements that aircraft make around their three axes, to include:

- roll about the longitudinal axis;
- pitch about the lateral axis; and
- yaw about the vertical axis.

Rolling. Movement of an aircraft about the longitudinal axis is called roll.

Pitching. Movement of an aircraft about the lateral axis is called pitch.

Yawing. Movement of an aircraft about the vertical axis is called yaw.

Show the cadets a slide or distribute handouts of aircraft axes in Figure 11K-1, bringing their attention to the motions of roll, yaw and pitch.

CONFIRMATION OF TEACHING POINT 2

QUESTIONS

Q1. What is roll?

Q2. What is pitch?

Q3. What is yaw?

ANTICIPATED ANSWERS

A1. Roll is the movement of an aircraft about its longitudinal axis.

A2. Pitch is the movement of an aircraft about its lateral axis.

A3. Yaw is the movement of an aircraft about its vertical axis.

Teaching Point 3 **Discuss Simultaneous Axial Movement of an Aircraft**

Time: 5 min Method: Group Discussion

BACKGROUND KNOWLEDGE

The point of the group discussion is to draw the following information from the group using the tips for answering/facilitating discussion and the suggested questions provided.

It is possible for an aircraft to move in only one axis at a time but it is not necessary. Although an aircraft can climb or descend using only pitch around the lateral axis, movement around all three axes simultaneously is necessary for efficient flight.

Show the cadets a slide or distribute handouts of aircraft axes in Figure 11K-1.

When riding a bicycle around a high-speed turn, it is necessary to not only yaw to make the turn, but efficient cycling requires the cyclist to lean into the turn, (or roll) slightly as the turn is made. A turn without leaning would be very slow and inefficient and would be the mark of a beginner cyclist.

Using a model aircraft, demonstrate that a turn with only yaw requires that the aircraft side-slip.

Similarly, an aircraft normally makes a “bank” manoeuvre in a level turn, involving movement about the longitudinal as well as the vertical axis. A climbing or descending turn requires that movement around the lateral axis be included as well.

Demonstrate a climbing turn with a model aircraft.

GROUP DISCUSSION

TIPS FOR ANSWERING/FACILITATING DISCUSSION

- Establish ground rules for discussion, e.g. everyone should listen respectfully; don't interrupt; only one person speaks at a time; no one's ideas should be made fun of; you can disagree with ideas but not with the person; try to understand others as much as you hope they understand you; etc.
- Sit the group in a circle, making sure all cadets can be seen by everyone else.
- Ask questions that will provoke thought; in other words avoid questions with yes or no answers.
- Manage time by ensuring the cadets stay on topic.
- Listen and respond in a way that indicates you have heard and understood the cadet. This can be done by paraphrasing their ideas.
- Give the cadets time to respond to your questions.
- Ensure every cadet has an opportunity to participate. One option is to go around the group and have each cadet answer the question with a short answer. Cadets must also have the option to pass if they wish.
- Additional questions should be prepared ahead of time.

SUGGESTED QUESTIONS

Q1. Can an aircraft turn around one axis at a time? Why?

Q2. What axial movements are normally used in a level turn? Why?

Q3. What manoeuvre requires movement around all three axis simultaneously? Why?

Q4. How does an aircraft bank?

Other questions and answers will develop throughout the group discussion. The group discussion should not be limited to only those suggested.

Reinforce those answers given and comments made during the group discussion, ensuring the teaching point has been covered.

CONFIRMATION OF TEACHING POINT 3

The cadets' participation in the group discussion will serve as confirmation of the TP.

Teaching Point 4 **Brainstorming How Aircraft Flight Might Be Controlled**

Time: 5 min Method: Group Discussion

BACKGROUND KNOWLEDGE

The point of the group discussion is to draw the following information from the group using the tips for answering/facilitating discussion and the suggested questions provided.

Have the cadets brainstorm various methods of controlling yaw, roll and pitch. Encourage them to "think outside the box". Tell them that the usual way of accomplishing control is only one of many that have been tried and used successfully over the years (Hint: a space shuttle and a helicopter both use different methods at different times).

GROUP DISCUSSION

TIPS FOR ANSWERING/FACILITATING DISCUSSION

- Establish ground rules for discussion, e.g. everyone should listen respectfully; don't interrupt; only one person speaks at a time; no one's ideas should be made fun of; you can disagree with ideas but not with the person; try to understand others as much as you hope they understand you; etc.
- Sit the group in a circle, making sure all cadets can be seen by everyone else.
- Ask questions that will provoke thought; in other words avoid questions with yes or no answers.
- Manage time by ensuring the cadets stay on topic.
- Listen and respond in a way that indicates you have heard and understood the cadet. This can be done by paraphrasing their ideas.
- Give the cadets time to respond to your questions.
- Ensure every cadet has an opportunity to participate. One option is to go around the group and have each cadet answer the question with a short answer. Cadets must also have the option to pass if they wish.
- Additional questions should be prepared ahead of time.

QUESTIONS

Q1. How might the pilot of an aircraft control the aircraft's movements during flight?

Q2. How do you think yaw might be controlled?

Q3. How do you think pitch might be controlled?

Q4. How do you think roll might be controlled?

Other questions and answers will develop throughout the group discussion. The group discussion should not be limited to only those suggested.

Reinforce those answers given and comments made during the group discussion, ensuring the teaching point has been covered.

CONFIRMATION OF TEACHING POINT 4

The cadets' participation in the group discussion will serve as confirmation of the TP.

END OF LESSON CONFIRMATION

SUGGESTED QUESTIONS

Q1. Name one axial aircraft movement and its associated axis.

Q2. Name a second axial aircraft movement and its associated axis.

Q3. Name a third axial aircraft movement and its associated axis.

ANTICIPATED ANSWERS

A1. Roll is the axial movement around an aircraft's longitudinal axis.

A2. Pitch is the axial movement around an aircraft's lateral axis.

A3. Yaw is the axial movement around an aircraft's vertical axis.

CONCLUSION

HOMEWORK/READING/PRACTICE

N/A.

METHOD OF EVALUATION

N/A.

CLOSING STATEMENT

Movement through a three-dimensional space requires three axes of movement. The names of the axes and the names of the movements are borrowed from the sea, where ships have pitched, yawed and rolled for thousands of years.

INSTRUCTOR NOTES/REMARKS

N/A.

REFERENCES

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C3-116 A-CR-CCP-263/PT-001/(ISBN 0-9680390-5-7) MacDonald, A. F. and Peppler, I. L. (2000). *From the Ground Up: Millennium Edition.* Ottawa, ON: Aviation Publishers Co. Limited.