Guidance to Instructors on Subject Delivery

SATELLITE AND DATA COMMUNICATIONS

Programme of learning:

- This is a suggested programme for the delivery of this subject.
- The main headings are the Learning Outcomes (LO1, LO2, etc), with sub headings related to topics within those Learning Outcomes (see Glossary of Terms).

Activities:

- Some practical activities are suggested throughout the programme as a way of reinforcing the learning and adding interest.
- It may be not be practical to undertake all of these activities at the suggested part of the programme.
- Instructors may have to adapt this programme to prevailing circumstances.

Method of delivery:

- Learning resources can be found on Ultilearn and may be adapted by the instructor, if required.
- Lesson delivery should be as practical as possible and should contain the maximum amount of cadet participation and interaction.

Check of understanding:

- Each lesson should contain a check of understanding (see Glossary of Terms).
- At the start of each lesson, the previous check of understanding should be reviewed in order to consolidate previous learning before moving on to new learning.

Formative assessment:

- There should be a formative assessment at the conclusion of each Learning Outcome (see Glossary of Terms).

Summative assessment:

- This is the Online Assessment, through Ultilearn, of the Assessment Criteria for this subject (see Glossary of Terms).
- Assessment Criteria (see Glossary of Terms) are found on the final page of this document.

SATELLITE AND DATA COMMUNICATIONS
Introduction: • Introduction to the subject and assessment method
LO1: Know main types and roles of satellites and principles of earth orbit
Introduction: • Introduce the main types of satellite and the principles of earth orbit
Satellites: • Introduce the topic of satellites • Explain the history of the development of satellites • Explain the definition of a satellite
Activity 1: • Cadets should investigate the types and roles of satellites from the internet and compare outcomes with the group

Orbits:
• Introduce orbits
• Explain the definition of orbit/s
• Explain the types, including:
  ○ Low earth orbit
  ○ Medium earth orbit
  ○ Geostationary earth orbit
• Explain the following:
  ○ The functions of orbits
  ○ Orbit slots
  ○ Space junk
  ○ How satellites stay in orbit

Launch process:
• Introduce the launch process
• Explain the following:
  ○ Launch phase
  ○ Orbit injection phase
  ○ Perigee
  ○ Transfer
  ○ Apogee

Satellite communications basics:

- Introduce the basics of satellite communications
- Explain the use of earth stations
- Explain the satellite footprint
- Explain the transmission systems and methods, including:
    - Uplink
    - Downlink

Types of satellite:

- Explain the types of satellite, their uses and who uses them, including:
    - Astronomy
    - Communication
    - Navigation
    - Reconnaissance
    - Remote sensing
    - Search and rescue
    - Space exploration
    - Weather stations

Formative assessment:

- Formative assessment of the main types of satellites and the principles of earth orbit

Main components:

- Introduce the main components of a satellite

Satellite housing:

- Introduce satellite housing
- Explain configurations of the satellite housing
- Explain the reasons for determining the housing, including stabilisation system
- Explain the principle of three axis stabilised satellites
- Explain the design features, including:
    - Solar array
    - Reaction control thrusters
    - Apogee kick motor nozzle cone
    - Hydrazine propellant tanks
    - Communications antennae

Power system:

- Introduce the power system
- Explain the types of power sources, including:
    - High performance batteries
    - Solar cells
- Explain the advantages of each type of system, for example; solar are lightweight, resilient and efficient
- Explain the disadvantages of each type, for example; solar does not work during eclipses
- Explain the ways of overcoming disadvantages

Antenna system:

- Introduce the antenna system
- Explain the purpose, including the receiving and transmitting of:
    - Telecommunications signals
    - Tracking
    - Telemetry
    - Commands
- Explain system priority, reasons and consequences, for example; no command function and the satellite could drift out of control

Command and control system:

- Introduce the command and control system
- Explain the purpose and method of operation

Station keeping:

- Introduce the principle of station keeping
- Explain the definition of station keeping
- Explain the disturbing forces, what they are and their outcome
- Explain the control mechanism and how it operates, for example; ejection of hydrazine gas
- Explain the lifespan of process

Transponders:

- Introduce transponders
- Explain the definition of a transponder
- Explain the means of operation and the typical output
- Explain the number of transponders used typically on satellites

Formative assessment: • Formative assessment of the main components of a satellite
Review: • Review the main types of satellite and the principles of earth orbit
Formative assessment: • Formative assessment of the main types of satellite and the principles of earth orbit

SATELLITE AND DATA COMMUNICATIONS
LO2: Know components and principles of a Global Positioning System
Introduction: • Introduce the basic principles and components of a Global Positioning System
History: • Explain the history of Global Positioning Systems
Activity 1: • Cadets should discuss what they know about GPS systems and their uses
Method of operation: • Explain the basic method of operation

Components:
• Introduce the components of Global Positioning Systems
• Explain the main parts and their uses, including:
  ○ Space segment
  ○ User segment
  ○ Control segment

Constellation of satellites:
• Introduce the principle of the constellation of satellites
• Explain GPS satellite orbits
• Explain timing, including:
  ○ Atomic clock
  ○ Method of operation
  ○ Measurement
• Explain the calculation of latitude, longitude and altitude
• Explain the benefits of using four or more satellites

Receivers:
• Introduce receivers
• Explain the uses and where used, including:
  ○ Aircraft
  ○ Ships
  ○ Tanks
  ○ Submarines
  ○ Cars

- Trunks
- Personal mobile phones

- Explain the method of operation

Ground stations:

- Introduce the principle of ground stations
- Explain the GPS control segment, including:
  - Master control station
  - Unstaffed monitoring stations
  - Large ground antenna station
- Explain the method of operation, including:
  - Role of monitoring stations
  - Adjustment control

How GPS works:

- Introduce how GPS works
- Explain the method of measurement, including measurements for:
  - Time
  - Position
  - Distance
- Explain the method of calculation, for example; receiver distance from satellite in time
- Explain the standard applied to GPS, for example; World Geodetic System 1984 (WGS84)

Military GPS:

- Introduce GPS in the military
- Explain how military GPS works and why

GPS in everyday life:

- Introduce the GPS in everyday life
- Explain and demonstrate moving map GPS displays
- Explain the non-military uses in the public services, including:
  - Police
  - Fire
  - Medical
- Explain the uses in mapping, including:
  - Map making
  - Surveying

- Construction
- Mining

- Explain vehicle tracking, including:
  - Private cars
  - Fleet vehicles
  - Public transportation
  - Delivery trucks
  - Courier services
- Explain GPS use in balloons, for example to monitor holes in the ozone layer
- Explain GPS use in buoys, for example; tracking tides and oil spills
- Explain GPS use in scientific research, including:
  - Archaeologists
  - Biologists
  - Explorers
- Explain GPS use in entertainment, leisure and other person applications, for example:
  - Boating
  - Hill walking
  - Keeping track of children
  - Managing the location of parolees

Activity 2:

- Cadets should experiment with as many types of GPS equipment as possible, for example; mobile phones, car navigation, walking handsets

Review:

- Review the basic principles and components of a Global Positioning System

Formative assessment:

- Formative assessment of the basic principles and components of a Global Positioning System

SATELLITE AND DATA COMMUNICATIONS
LO3: Know principles of data communication
Introduction: • Introduce the principles of data communication
Types and roles: • Introduce types and roles of mobile communication • Explain transfer of data and the method of transfer • Explain the preservation of data during transfer
Protocols: • Introduce the protocols of data communication • Explain the uses and methods of use
Networks: • Introduce types of networks • Explain the following: o Personal area networks o Local area networks o Wide area networks o Internet o World wide web o Intranet o Extranet o Wireless networks o Wi-fi
Security: • Introduce network security • Explain the uses and methods of use
Network servers: • Introduce the principle of computer network servers • Explain the methods of use, for example server farms
Activity 1: • Cadets should experiment with different types of data communications equipment and note the principle purpose of each

Review: • Review the principles of data communication
Formative assessment: • Formative assessment of the principles of data communication

SATELLITE AND DATA COMMUNICATIONS
LO4: Know types and roles of mobile communication
Introduction: • Introduce the basic principles of mobile communication
Design concepts: • Introduce the design concepts of mobile communication • Explain the main components of a mobile communication network, for example the mobile device

Scientific concepts:
• Introduce the scientific concepts of mobile communication
• Explain the applications of the following:
  ○ Mobile phones
  ○ Mobile data devices
  ○ Internet
  ○ Worldwide web

Bluetooth:
• Introduce Bluetooth
• Explain the definitions of Bluetooth communications
• Explain the method of operation and security, including:
  ○ 2.4 GHz band
  ○ No licence or subscription
  ○ 128-bit encryption
  ○ PIN code
• Explain the operating range by class, for example; 100 metres for Class 1
• Explain what the electronic devices are that can be supported

Wi-fi:
• Introduce wi-fi
• Explain the definition, for example; wireless fidelity
• Explain the uses, including:
  ○ Computers
  ○ Mobile phones
  ○ PDAs
  ○ Other wirelessly communicating
• Explain the methods of operation

• Explain the principle of hotspots • Explain voice over internet protocol
Activity 1: • Cadets should experiment with the different types of equipment in order to experience their uses
Review: • Review the basic principles of mobile communication
Formative assessment: • Formative assessment of the basic principles of mobile communication

SATELLITE AND DATA COMMUNICATIONS
Subject review: • Review of the subject and activities
Preparation for summative assessment: • Prepare for Online Assessment on Ultilearn

SATELLITE AND DATA COMMUNICATIONS	
Assessment Criteria for Each Learning Outcome	
Subject	**Satellite and Data Communications**
Classification	Senior Cadet / Master Air Cadet
BTEC Aviation Studies	Unit 19: Satellite and Data Communications for Air Cadets
Learning Outcome The learner will:	**Assessment Criterion** The learner can:
LO1: Know main types and roles of satellites and principles of earth orbit	P1: Describe the principles of earth orbit
	P2: Identify uses of satellites
	P3: Identify phases that a satellite undergoes
	P4: Describe how station keeping is managed
	P5: Identify use of the main components of a satellite
LO2: Know components and principles of a Global Positioning System	P6: Describe how a Global Positioning System works
	P7: Identify components of a Global Positioning System
	P8: Describe the application of a constellation of satellites for Global Positioning
	P9: Identify types of Global Positioning System ground stations
	P10: Identify uses of Global Positioning Systems in the military and everyday life
LO3: Know principles of data communication	P11: Describe protocols used for data communication
	P12: Identify types of data networks
	P13: Describe use of data network servers
LO4: Know types and roles of mobile communication	P14: Identify main components of a mobile communications network
	P15: Identify applications of mobile communications

	P16: Describe the definition and use of Bluetooth and Wi-Fi

ACO Aviation Training Syllabus

Glossary of Terms

Term	Meaning
Learning outcomes	What a cadet is expected to know, understand or be able to do.
Assessment criteria	The standard a cadet is expected to meet to demonstrate that a learning outcome, or set of learning outcomes, has been achieved.
Guidance to instructors on subject delivery	A programme that gives the instructor guidance on the content and suggested order of delivery for a particular subject. It will include the learning outcomes, what should be covered to achieve those outcomes and any relevant practical activities.
Formative assessment	Regular and informal assessment that provides feedback throughout the learning process that supports the cadet's progress. This can take the form of checks of understanding through question and answer sessions or demonstration of an activity.
Summative assessment	Assessment of learning by an HQ Air Cadets paper-based examination or online assessment. A cadet will have to correctly answer a question that directly relates to an assessment criterion.
Examination	Paper-based exclusive choice question paper for the old syllabus subjects for Leading, Senior and Master Air Cadet.
Online assessment	Online assessment process, accessed through Ultilearn, for Leading Cadet from Sep 10 and Senior and Master Air Cadet from Sep 11.
Lesson check of understanding	Throughout and at the end of each lesson there should be a check of understanding. At the start of the next lesson, the previous check of understanding should be reviewed in order to consolidate previous learning before moving on to new learning.
Check of understanding for First Class Cadet	This is a competence-based assessment process for First Class Cadet which should test understanding through practical demonstration, activity observation, oral questioning and inspection.