5. ביצועי אנוש

5.1 HUMAN FACTORS BASIC CONCEPTS

5.1.1 Human Factors in aviation

-State that Human Factors training is an ICAO and CAA requirement.

-Justify the relevance of Human Factors in aviation.

5.1.1.1 Competence and limitations

-Define the roles played by various participants in aviation activities with respect to flight safety and the limitations of individuals and organizations in the improvement to flight safety.

5.1.1.2 Becoming a competent pilot

-Describe the general classification of the factors to be considered in assessing the competency of any individual pilot.

-Outline the factors in training that will ensure the future competency of the individual pilot, e.g. the relationship between self-confidence and expertise.

5.1.2 Accident statistics

-State in general terms the percentage of aircraft accidents which are caused by human factors and commonly described as 'pilot error.'

-Name the major single cause for a pilot induced accident.

-Summarize the accident trend in modern aviation.

-Identify the role of accident statistics in developing a strategy for future improvements to flight safety.

-Name the most significant item of technical equipment introduced in the 1980s and 1990s which has contributed to the reduction of accidents.

5.1.3 Flight safety concepts

-Analyze the flight accident statistics and point out the proportion of human error. Discuss its implication for flight safety concepts.

-Indicate the importance of error detection and list various methods of detection.

-Explain the importance for flight safety of understanding the causes and categories of accidents and incidents.

-Describe and compare the elements of the SHELL model.

-Summarize the relevance of the SHELL model to work in the cockpit.

-Analyze the interaction between the various components of the SHELL model.

5.2 BASIC AVIATION PHYSIOLOGY AND HEALTH MAINTENANCE

5.2.1 Basics of flight physiology

-List those factors which may affect the normal working of the human body when in flight.

5.2.1.1 The atmosphere

-State the units used in measuring total and partial pressures of the gases in the atmosphere.

-State in terms of % and mm Hg the values of Oxygen, Nitrogen and other gases present in the atmosphere.

-State the physiological significance of the following Laws and be able to carry out calculations using those laws:

- -Boyle's Law
- -Dalton's Law
- -Henry's Laws
- -The General Gas Law

-State at what altitudes in the standard atmosphere the atmospheric pressure will be 1/4, 1/3 and 1/2 of MSL pressure.

-State the effects of increasing altitude on the overall pressure and partial pressures of the various gases in the atmosphere.

5.2.1.2 Respiratory and circulatory systems

-List the main components of the respiratory system and their function.

-State the values for the normal rate of breathing and the volume of air exchanged with each normal breath ('tidal volume').

-State how oxygen and carbon dioxide are transported throughout the body.

-Explain the process by which oxygen is transferred to the tissues and carbon dioxide is eliminated from the body.

-Name the major components of the circulatory system and describe their function.

-Define 'systolic' and 'diastolic' blood pressure and give standard values for an adult at rest.
-Explain the function of the hemoglobin and state the percentage of oxygen saturated in the blood at MSL and at 10,000 ft.
-Define the following terms associated with failures in the respiratory/circulatory systems and analyze their significance for the conduct of a safe flight:

-Hypoxia
- -Define 'hypoxia' and state why living tissues require oxygen.
- -State that healthy people are able to compensate for altitudes up to 10 - 12,000 ft.
- -List the signs and symptoms of hypoxia, define their characteristics and determine their role in flight safety.
- -Define the terms 'Time of Useful Consciousness' (TUC) and 'Effective Performance Time' (EPT.(
- -State the TUC for 20,000 ft, 30,000 ft, 35,000 ft and 43,000 ft for a person at rest and for 25,000 ft when the person is moderately active.
- -Explain why it is unsafe to fly above 10 - 12,000 ft without using additional oxygen or being in a pressurized cabin.
- -List the factors determining the severity of hypoxia.
- -State the precautions to be taken when giving blood.

-Hyperventilation
- -Define the term 'hyperventilation.'
- -List the signs and symptoms of hyperventilation and define their characteristics.
- -List measures which may be taken to counteract hyperventilation.

-Decompression Sickness
- -State the normal range of cabin pressure altitude in pressurized commercial aircraft and describe their protective function for aircrew and passengers
- -Define the hazards of diving and flying and give the regulations associated with these activities.

-Acceleration

-Define 'linear', 'angular' and 'radial acceleration.'
-Describe the effects of acceleration on the circulation and blood volume distribution.
-Describe measures which may be taken to increase tolerance to positive acceleration.

-Anemic hypoxia
-Define 'anemia.'
-State how carbon monoxide may be produced.
-State how the presence of carbon monoxide in the blood affects the distribution of oxygen.
-List the signs and symptoms of carbon monoxide poisoning.
-Indicate how carbon monoxide intoxication can be treated.

5.2.2 Man and environment: the sensory system

-List the different senses.
- State the multi-sensory nature of human perception.

5.2.2.1 Vision
-Name the most important parts of the eye and the pathway to the visual cortex.
-State the basic functions of the parts of the eye.
-Distinguish between the functions of the rod and cone cells.
-Explain the terms 'visual acuity', 'visual field', 'central vision', 'peripheral vision', 'fovea' and explain their function in the process of perception.
-State the limitations of night vision.
-Explain the basic principles of color vision and their relevance to flight duties.
-Explain the nature of color blindness.

5.2.2.2 Hearing
-Name the most important parts of the ear and the associated neural pathway.
-State the basic functions of the different parts of the auditory system.
-Differentiate between the functions of the vestibular apparatus and the cochlea in the inner ear.
-Summarize the effects of environmental noise on hearing.
-Identify the potential occupational risks which may cause hearing loss.
-State the role of the Eustachian tube in equalizing pressure

between the middle ear and the environment Indicate the effects of colds or flu on the ability to equalize pressure in the above.

5.2.2.3 Integration of sensory inputs

-Define the term 'illusion.'

-Give examples of visual illusions based on shape constancy, size constancy, aerial perspective, atmospheric perspective, the absence of focal or ambient cues, autokinesis, vectional false horizons and surface planes;

-Relate these illusions to problems that may be experienced in flight and identify the danger attached to them.

-Give examples of approach and landing illusions, state the danger involved and give recommendations to avoid or counteract these problems.

-State the problems associated with flickering lights (strobe-lights, anti-collision lights, etc).

-List the type of external stimuli that the components of the inner ear are able to perceive.

-Define 'vertigo', list the corresponding symptoms and identify the flight maneuvers provoking it.

-Differentiate between vertigo, coriolis effect and spatial disorientation.

-Explain how spatial disorientation can result from a mismatch in sensory input and information processing.

-List the measures to prevent and/or overcome spatial disorientation and/or vertigo in flight.

5.2.3 Health and hygiene

5.2.3.1 Personal hygiene

-Summarise the role of personal hygiene as a factor in human performance.

5.2.3.2 Common minor ailments

-List the negative effects of suffering from colds or flu on flight operations especially with regard to the middle ear, the sinuses, and the teeth.

-Explain the effects of pressure changes to structures in the ear and the implications of these effects.

-State the role of the Eustachian tube in equalizing pressure

between the middle ear and the environment.

-Indicate the effects of colds or flu on the ability to equalize pressure between the middle ear and the environment.

-Describe the measures to prevent and/or clear problems due to pressure changes during flight.

-Define 'Barotrauma.'

LEARNING OBJECTIVES

-Indicate the major sources of gastro-intestinal upsets , state the effects that may result during flight and list the precautions that should be observed to reduce the occurrence of these problems.

5.2.3.3Problem areas for pilots

-Hearing loss

-List the main cause of hearing loss.

-List the main sources of hearing loss in the flying environment.

-List the precautions that may be taken to reduce the probability of onset of hearing loss.

-Defective vision

-State the corrective action necessary to compensate for defective vision.

-List the type of sunglasses which could cause perceptional problems in flight.

-Techniques in visual perception

-Define the term 'scanning technique.'

-Explain, why it is important to visually scan the area by using regularly spaced eye movements each covering an overlapping sector of about 10 degrees.

-State the rule, at present in force, for the wearing of corrective spectacles or contact lenses when operating as a pilot.

-Explain the difference between the scanning technique used during the day and the appropriate technique to be used when flying at night.

-State the effect that the duration of a saccade has on determining scanning patterns both inside and outside the cockpit.

5.2.3.4 Intoxication

-Tobacco

-State the harmful effects of using tobacco on:
-The respiratory system
-The cardio-vascular system
-The ability to resist hypoxia
-The ability to tolerate g forces
-Night vision

-Caffeine

-Indicate the level of caffein dosage at which performance is degraded.
-Besides coffee, indicate other beverages containing caffeine.

-Alcohol

-Give a general rule governing flying and drinking alcohol.
-State the effects of consuming alcohol on:
-Ability to reason
-Inhibitions and self control
-Vision
-Sense of balance and sensory illusions
-Sleep patterns
-Hypoxia
-State the effects alcohol may have if consumed together with other drugs.
-Identify the WHO definition of 'alcoholism.'
-List the signs and symptoms of alcoholism.
-List the factors which may be associated with the development of alcoholism.
-Define the 'unit' of alcohol and state the most effective factor determining the rate of metabolisation.
-State the maximum daily and weekly intake of units of alcohol which may be consumed without causing damage to organs and systems in the body.
-State the actions to be taken if a crew member is suspected of being an alcoholic.

-Drugs and self medication

-State the dangers associated with the use of non prescription drugs.

-State the side affects of common non prescription drugs used to treat colds, flu, hay fever and other allergies especially medicines containing anti-histamine preparations.
-Interpret the general rule that 'if a pilot is so unwell that he/she requires any medication then he/she should consider him/herself unfit to fly.

-Toxic materials
-List those materials present in an aircraft which may, when uncontained, cause severe health problems.
-State the dangers of mercury spillage in an aircraft.
-List the possible sources of mercury in an aircraft.
-List those aircraft component parts which if burnt may give off toxic fumes.

5.3 BASIC AVIATION PSYCHOLOGY

5.3.1 Human information processing

5.3.1.1 Attention and vigilance

-Differentiate between 'attention' and 'vigilance.'
-Define 'hypovigilance.'
-Identify the factors which may affect the state of vigilance.
-List the factors that may forestall hypovigilance during flight.
-Indicate signs of reduced vigilance.
-Name factors that affect a person's level of attention.
-Distinguish between selective and divided attention.
-Discuss the effects of performing simultaneous tasks in respect to the level of consciousness involved and demonstrated level of performance.
-Discuss consequences for work in a multi-task environment, bearing attention and vigilance in mind. Name procedures which increase safety.

5.3.1.2 Perception

-Name the basis of the perception process.
-Describe the mechanism of perception ('bottom-up'/'top-down' process(
-Illustrate why perception is subjective and state the relevant

factors which influence interpretation of perceived information.
-Describe some basic perceptual illusions.
-Illustrate some basic perceptual concepts and laws.
-Give examples where perception plays a decisive role in flight safety.

5.3.1.3 Memory

-List the three types of memory.
-Explain the link between the three types of memory.
-Describe the differences between the three types of memory in terms of capacity and retention time.
-Justify the importance of sensory store memories in processing information.
-State the average maximum number of separate items that may be held in working memory.
-Give examples of items that are important for pilots to hold in working memory during flight.
-Describe how the capacity of the working memory store may be increased.
-State the sub-divisions of long term memory and give examples of their content.
-Define the three different categories of information stored in long term memory.
-Name the common problem with long term memory and how to counteract it.

5.3.1.4 Response selection

-Define 'learning.'
-Explain and distinguish between the following basic forms of learning:
-Classical and operant conditioning (behaviorist approach(
-Learning by insight (cognitive approach(
-Learning by imitating (modeling.(
-Find pilot related examples for each of these learning forms.
-State factors which are necessary for and promote the quality of learning.

-Explain ways to facilitate the memorization of information by the following learning techniques:

-Mnemonics
-Mental training
-Explain the relationship between motivation and learning, performance, and attention
-Describe the advantage of planning and anticipation of future actions.
-Define the term 'skills.'
-State the phases of learning a skill (ANDERSON.(
-Explain the term 'motor-programme' or 'mental schema.'
-Explain the following phases in connection with the acquisition of automated behavior:
-Cognitive phase
-Associative phase
-Automatic phase.
-Describe the advantages and disadvantages of mental schemata.
-Explain the model by RASMUSSEN which describes the guidance of a pilot's actions in different situations.
-State possible problems or risks associated with skill-based, rule-based, and knowledge-based behavior.

5.3.2 Human error and reliability

5.3.2.1 Reliability of human behavior

-Summarize the current approach to human error in aviation. Identify the consequences in respect of the current approach.
-Name and explain factors which influence human reliability.

5.3.2.2 Hypotheses on reality

-Cite examples of the relationship between perception and reality in given circumstances.
-List factors which influence one’s sense of reality.
-Define the term 'mental model' in relation to a surrounding complex situation.
-Describe the advantage/disadvantage of mental models.
-Explain the relationship between personal ‘mental models’ and the creation of cognitive illusions.

5.3.2.3Theory and model of human error

-Define the term 'error.'
-Explain the concept of the error chain.
-Differentiate between an isolated error and an error chain.
-State examples of an isolated error and an error chain.
-Distinguish between different forms/types of errors (e.g. RASMUSSEN, REASON).
-Compare unintended and intended deviations from standards, leading to negative consequences.
-Distinguish between an active and a latent error and give examples.

5.3.2.4 Error generation

-Distinguish between internal and external factors in error generation
-Identify possible sources of internal error generation.
-Define the term 'environmental capture.'
-Define the term 'deterioration effect.'
-List the three main sources for external error generation.
-Give examples to illustrate the following factors in external error generation in the cockpit:
-Ergonomics
-Economics
-Social environment.
-Name major goals in the design of human centered man-machine interfaces.
-Define the term 'error tolerance.'
-List (and describe) strategies which are used to reduce human error.

5.3.2.5 Decision making

-Define the term 'deciding' and 'decision making.'

5.3.2.6 Decision making concepts

-Describe the major factors on which a decision-making should be based during the course of a flight ('Judgment Concept.('
-Describe the main positive capabilities in an individual's decision making mechanism.
-Describe the main error sources and limits in an individual's

decision making mechanism.
-State the factors upon which an individual's risk assessment is based.
-Explain the relationship between risk assessment, commitment, and pressure of time on decision making strategies.
-Describe the positive and negative influences exerted by other group members on an individual's decision making process.
-Explain the general idea behind the creation of particular models' guidelines for decision making processes.
-Illustrate a practical approach for decision making between crew members.

5.3.3 Avoiding and managing errors: cockpit management

5.3.3.1 Safety awareness

-Justify the need for being aware of one's own performance before and during a flight and possible consequences of its result as part of a pilot's professionalism.
-Define the term 'situation(al) awareness.'
-Name the three cognitive elements which are necessary to create an adequate situation awareness.
-Identify factors which interfere with being 'situationally aware.'
-List cues which indicate the loss of situation awareness.
-Name the main steps towards regaining lost situation awareness.
-Justify the value of situation awareness in the context of flight safety

5.3.4 Personality

5.3.4.1 Personality and attitudes

-Describe the factors which determine an individual's behavior.
-Define and distinguish between personality, attitude, and behavior.
-State the origin of personality and attitudes.
-Summarize the influence of pilot relevant personality traits and dangerous attitudes on pilots' performance in the cockpit environment.

5.3.4.2 Individual differences in personality

-Describe the individual differences in personality by the mean of a common trait model (e.g., EYSENCK's personality factors) and use it to describe today's ideal pilot.
-State the most important personality trait for effective crew decision making.
-Motivation
-Define motivation.
-Explain the influences of different level of motivation on performance in taking into consideration arousal and task difficulty.
-Explain the 'Model of human needs' (MASLOW.(
-Distinguish between the stages of the 'Model of human needs' by citing practical examples.
-Illustrate the influence of human needs on flight safety.
-Explain the basic model that identifies two independent sources of motivation; justify its conclusion on possible developments concerning an individual's job satisfaction.
-Summarize the advantages and disadvantages of extreme need for achievement.

5.3.5 Human overload and underload

5.3.5.1 Arousal

-Explain the term 'arousal.'
-Describe the relationship between arousal and performance.
-Understand the graphical representation of the above relationship.

5.3.5.2 Stress

-Explain the term 'homeostasis.'
-Explain the term 'stress'. Why is stress a natural human reaction.
-State that the physiological response to stress is generated by the 'fight or flight' response.
-Describe the function of the autonomic nervous system (ANS) in stress response.
-Explain the biological reaction to stress by means of the 'general adaptation syndrome' (GAS.(
-Explain the relationship between arousal and stress by referring to the effects of "good" and "bad" stress.
-State the relationship between stress and performance.

-Explain the differences between stress factors and stress reactions.
-State the basic categories of stress factors.
-Name major stress factors.
-List the major environmental sources of stress in the cockpit.
-State the acceptable amount of workload with regard to crew resources available, before it becomes an unacceptable stress factor.
-Name the principal causes of domestic stress.
-State that the stress experienced as a result of particular demands varies between individuals.
-Explain the process which is responsible for the individual differences in experiencing stress.
-Explain the difference between stress factors and risk factors.
-List factors influencing the tolerance of stressors.
-Create and explain a simple model of stress.
-Explain the relationship between stress and anxiety.
-Describe the effects of anxiety on human performance.
-State the general effect of acute stress on the human system.
-Name the symptoms of stress relating to the different phases of the GAS.
-Describe the relationship between stress, attention, and vigilance.
-State the general effect of chronic stress on the human system.
-Explain the differences between psychological, psychosomatic and somatic stress reactions.
-Name typical common physiological and psychological symptoms of human overload.
-Describe effects of stress on the personality.
-Explain how stress is cumulative and how stress from one situation can be transferred to a different situation.
-Explain how successful completion of a stressful task will reduce the amount of stress experienced when a similar situation arises in the future.
-List sources and symptoms of human underload.
-Describe the effect of human under/overload on effectiveness in the cockpit.

5.3.5.3 Fatigue

-Explain the term 'fatigue' and differentiate between the two types of fatigue.
-Name causes for both types.

5.3.5.4 Body rhythms and sleep

-Name some internal body rhythms.
-Explain the term 'circadian rhythm.'
-State the approximate duration of a 'free-running' circadian rhythm.
-Explain the significance of 'Zeitgebers' in regulating the normal circadian rhythm.
-State the effect of the circadian rhythm of body temperature on an individual's performance standard and the effect on an individual's sleep patterns.
-List and describe the stages of a sleep cycle.
-Differentiate between REM and non-REM sleep.
-Explain the function of sleep and describe the effects of insufficient sleep on performance.
-Explain the simple calculations for the sleep/wake credit/debit situation.
-Explain how sleep debt can become cumulative.
-State the time formula for the adjustment of body rhythms to the new local time scale after crossing time zones.
-State the problems caused by circadian disrhythmia (jet-lag) on an individual's performance and sleep sequence.
-Differentiate between the effects of westbound and eastbound travel.
-Explain the interactive effects of circadian rhythm and vigilance on a pilot's performance during flight as the duty-day elapses.
-Describe the main effects of lack of sleep on an individual's performance.
-List possible coping strategies for jet-lag.

5.3.5.5 Fatigue and stress management

-List strategies which prevent or delay the onset of fatigue and hypovigilance.
-List and describe coping strategies for dealing with stress factors and stress reactions.
-Distinguish between short-term and long-term methods of stress management.
-Give examples of short term methods of stress management.
-Give examples of long-term methods of coping with stress.