

**ROYAL CIVIL SERVICE COMMISSION  
BHUTAN CIVIL SERVICE EXAMINATION (BCSE) 2020  
EXAMINATION CATEGORY: TECHNICAL**

**PAPER III: SUBJECT SPECIALISATION PAPER FOR AERONAUTICAL  
ENGINEERING**

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<b>Date</b>	: February 27, 2021
<b>Total Marks</b>	: 100
<b>Writing Time</b>	: 150 minutes (2.5 hours)
<b>Reading Time</b>	: 15 minutes (prior to writing time)

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**GENERAL INSTRUCTIONS:**

1. Write your Registration Number clearly and correctly on the Answer Booklet.
2. The first 15 minutes is to check the number of pages of the Question Paper, printing errors, clarify doubts and to read the instructions. You are NOT permitted to write during this time.
3. This paper consists of **TWO SECTIONS**, namely SECTION A & SECTION B:
  - **SECTION A** has two parts: Part I - 30 Multiple Choice Questions  
Part II - 4 Short Answer Questions  
  
All questions under SECTION A are COMPULSORY.
  - **SECTION B** consists of two Case Studies. Choose only **ONE** case study and answer the questions of your choice.
4. All answers should be written on the Answer Booklet provided to you. Candidates are not allowed to write anything on the question paper. If required, ask for additional Answer Booklet.
5. All answers should be written with correct numbering of Section, Part and Question Number in the Answer Booklet provided to you. Note that any answer written without indicating the Section, Part and Question Number will NOT be evaluated and no marks will be awarded.
6. Begin each Section and Part on a fresh page of the Answer Booklet.
7. You are not permitted to tear off any sheet(s) of the Answer Booklet as well as the Question Paper.
8. Use of any other paper including paper for rough work is not permitted.
9. **You must hand over the Answer Booklet to the Invigilator before leaving the examination hall.**
10. This paper has **9 printed pages**, including this instruction page.

**GOOD LUCK!**

SECTION A

PART I: Multiple Choice Questions [30 marks]

Choose the correct answer and write down the letter of your chosen answer in the Answer Booklet against the question number e.g. 31 (d). Each question carries ONE mark. Any double writing, smudgy answers or writing more than one choice shall not be evaluated.

1. International organisation 'ICAO' is an abbreviation of
  - a) International Court of Atomic Operation
  - b) International Civil Aviation Organisation
  - c) Intergovernmental Court of Atomic Operation
  - d) International Court of Aviation Operation
  
2. The aircraft lift depends on
  - a) Angle of attack
  - b) Wing shape and profile
  - c) Air density
  - d) All of the above
  
3. Which type of **drag** is the easiest to reduce when designing the aircraft?
  - a) Form drag
  - b) Induced drag
  - c) Skin friction drag
  - d) Interference drag
  
4. It is extremely important not to use any material that would leave a deposit of lead, copper, zinc, or similar material on any hot section part of gas turbine while marking as it will cause
  - a) Premature failure
  - b) Carburization
  - c) Intergranular attack
  - d) All of the above
  
5. As aspect ratio 'AR' is increased, induced drag is decreased. Hence, subsonic airplanes designed to minimize induced drag have \_\_\_\_\_ aspect ratio 'AR'.
  - a) low
  - b) very low
  - c) high
  - d) very high
  
6. The ratio of lift to drag is
  - a) a direct measure of the aerodynamic efficiency of a given airplane.
  - b) one of the driving aspects that dictate the configuration of the landing gears.
  - c) a major indicator of thrust available from the power of an airplane.
  - d) a direct measure of the stability of a given airplane.

7. The gas temperature in the \_\_\_\_\_ is not allowed exceeding the allowable structural temperature limits of the turbine.
- air inlet
  - compressor section
  - afterburner
  - combustion chamber
8. The wings of an airplane are designed to provide
- Thrust
  - Lift
  - Drag
  - Gravity
9. The function of conventional control surfaces (elevators, ailerons and rudder) on an airplane is not
- to change the airplane from one equilibrium position to another.
  - to produce non-equilibrium accelerated motion such as maneuvers.
  - to control the altitude and flight path (heading).
  - to control the airspeed and flight path (heading).
10. Rotational motions about the x, y and z-axis are called \_\_\_\_\_ respectively.
- pitch, roll and yaw
  - roll, pitch and yaw
  - yaw, pitch and roll
  - pitch, yaw and roll
11. The design aspect ratio for a conventional airplane is a compromise between
- materials and structural.
  - thrust and lift.
  - aerodynamics and structure.
  - weight and lift.
12. Which of the following is not a part of the airframe?
- Fuselage
  - Wing
  - Stabilizing tail
  - Landing gear
13. If the fluid is incompressible, do thermodynamics properties play an important role in its behaviour at varying temperature and pressure?
- Yes
  - No
  - Depends on the fluid
  - None of the above

14. Which of the following Binary numbers is equivalent to decimal number 24?

- a) 11000
- b) 11011
- c) 11001
- d) 11111

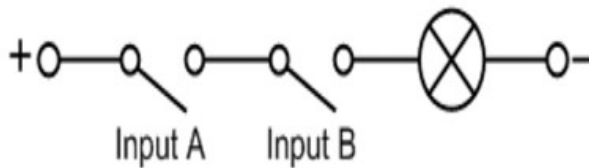
15. An element which consumes energy instead of storing in it is

- a) Conductor
- b) Inductor
- c) Capacitor
- d) Resistor

16. An engineering notation of  $10^{-15}$  is called

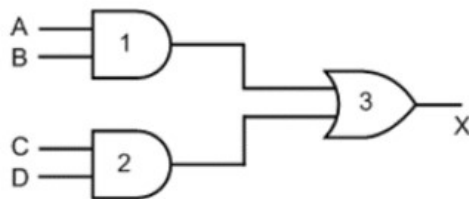
- a) Pico
- b) Giga
- c) Femto
- d) Atto

17. The figure given below is the simple equivalent circuit representation of



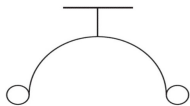
- a) AND gate
- b) OR gate
- c) NOT gate
- d) NOR gate

18. If the inputs to the circuits shown below are;  $A = 1$ ,  $B = 1$ ,  $C = 0$  and  $D = 1$ , what will the output  $X$  be?



- a) 0
- b) 1
- c) 2
- d) 3

19. In engineering drawing, the Title Blocks is usually placed in the
- upper left-hand side.
  - lower left-hand side.
  - upper right-hand side.
  - lower right-hand side.
20. In orthographic projection drawing, the possible views of an object are
- 4
  - 6
  - 8
  - 10
21. The retractable main landing gear on an airplane is a good example of a
- First class lever
  - Second class lever
  - Third class lever
  - None of the above.
22.  $10 \text{ ft}^3$  of nitrogen is under a pressure of 500 psi absolute. If the volume is reduced to  $5 \text{ ft}^3$ , what will the new pressure be?
- 1000 psi absolute
  - 2000 psi absolute
  - 3000 psi absolute
  - 4000 psi absolute
23. An airship is able to float in the atmosphere and a seaplane is able to float on water because
- gravitational force exerted on the body is less.
  - buoyant force is less than weight.
  - buoyant force is more than weight.
  - weight is more than buoyant force.
24. Dihedral design of the airplane wings improves
- Longitudinal stability
  - Lateral stability
  - Directional stability
  - Static stability
25. Identify the schematic symbol given below.



- Fuse
- Rheostat
- Circuit breaker
- Potentiometer

26. The thermodynamics cycle on which the gas turbine works is
- Otto cycle
  - Diesel cycle
  - Carnot cycle
  - Brayton cycle
27. How is the fly-by-wire system implemented in an aircraft?
- By using control rods and linkages connecting stick to control surfaces.
  - By using high power radio transmitters and receivers.
  - By using computers and actuators to control surfaces.
  - Artificial intelligence.
28. Why are both electrical and hydraulic systems used in the same aircraft?
- For quick deflections.
  - As a fail safe.
  - To generate more force.
  - Hydraulics for more force and electric for quick deflections.
29. How many ways can we select 6 people out of 10, of which a particular person is not included?
- ${}^9C^5$
  - ${}^{10}C^5$
  - ${}^9C^6$
  - ${}^{10}C^6$
30. How many Primary Flight Displays are present in a typical civil aircraft cockpit?
- 1
  - 2
  - 3
  - 4

**PART II – Short Answer Questions [20 marks]**

**This part has 4 Short Answer Questions. Answer ALL the questions. Each question carries 5 marks. Mark for each sub-question is indicated in the brackets.**

**Question 1**

- Define Avionics System. Give 3 examples. (2+1 marks)
- What are the basic components of a radio communication system? (2 marks)

**Question 2**

- State the Boyle's Law. Give 3 applications of Boyles's law in aviation. (2+2 marks)
- What do you understand by the term 'streamline shape'? (1 mark)

**Question 3**

- a) What are the four most important forces which act upon an aeroplane during the flight? (1 mark)
- b) If the drag of an aeroplane is equal to the thrust of the propeller in a straight and level flight, what makes the aeroplane go forward? (2 marks)
- c) Is an aeroplane in a state of equilibrium during:
  - i. A steady climb? (1 mark)
  - ii. Take-off? (1 mark)

**Question 4**

- a) A 13-stage compressor has a pressure ratio across each stage of 1.2 and an ambient inlet pressure of 14.7 psi.
  - i. What is the final pressure? (2 marks)
  - ii. What is the pressure or compressor ratio? (1 mark)
- b) What are the three most important factors that will affect the thrust of a gas turbine engine during operation? (2 marks)

**SECTION B: Case Study**

**Choose either CASE I OR CASE II from this section. Each case study carries 50 marks. Mark for each sub-question is indicated in the brackets.**

**CASE I**

Aviation in Bhutan came into inception in 1983 with Royal decree and the establishment of Drukair as national flag carrier and only operator in the country since then. However, Air Transportation being one of the safest modes of transportation and cost effective, there was a surge in the number of passengers opting for Air transport in the recent year. Presently, there are three operators: two international operators and one domestic helicopter operator. Some aspirant operators are in the pipeline for approval.

Even with the current three operators, Paro International Airport has become crowded and is facing a space constraint for carrying out line and base maintenance on the aircrafts. To mitigate the problem and give equal opportunity to all operators, besides other options, formation of a single Maintenance and Repair Organisation (MRO) is therefore felt necessary in the country to cater the needs for all operators.

You as an aeronautical engineer, write a proposal for forming a single MRO in order to tackle the space congestion problem.

Your proposal should include the following besides others:

- Define Maintenance and Repair Organisation (MRO).
- Importance of MRO.
- Achievement of maintenance on different types of aircraft registered in Bhutan.
- Compliance to regulatory requirements.
- Types of aircraft of maintenance engineers to employ.
- Advantages and disadvantages of forming a single MRO for all operators.
- Challenges.

## **CASE II**

On March 23, 2014, in XYZ Airport, a ground vehicle runway incursion incident was reported. The ground vehicle involved in the runway incursion was being operated by a runway maintenance company contracted by the aerodrome operator. The vehicle was manned by a driver who held an appropriate permit along with Radiotelephony (R/T) and an assistant who did not hold R/T.

On that day, the first officer was pilot flying the aircraft and captain was monitoring the instruments; both pilots reported not having seen the vehicle until after touch down when the aircraft was decelerating through approximately 100 knots. As a result of the sighting the presence of the vehicle on the ground, to the left of the runway centreline, the Captain had taken control of the aircraft and applied manual braking to increase the deceleration rate and made a deviation to the right to avoid collision with the ground vehicle. The outer left wing passed over the ground vehicle.

The ground vehicle was instructed by the ground movement controller to proceed to a designated holding point and to wait there for three to five minutes.

The tower controller, responsible for issuing aircraft landing clearance, verified visually that the ground vehicle had arrived at the holding point. A minute later, a third tower controller "in a supervisory role", who was unaware of the earlier clearance issued by the ground controller but was aware that the vehicle needed access to the runway to remove a dead bird (foreign object debris) and was instructed to proceed to the runway. The assistant driver was the one who had responded to the instruction given by the third tower controller. Neither the ground movement controller nor the previous tower controller had interrupted the instruction given by the controller in the supervisory position.

Following this clearance, the vehicle entered the runway with R/T switched off, crossing the red stop bar in accordance with prevailing procedure.

Eight seconds after the ground vehicle entered the runway, the tower controller also issued a landing clearance to the aircraft by visually scanning the runway but without checking the Advanced Surface Movement Guidance and Control System (A-SMGCS).



It was a normal practice not to refer to the A-SMGCS display when the visibility is good.

The investigation concluded that, had there been a more systematic approach to utilise the full capabilities of the A-SMGCS system, the controllers would have been alerted by the aural and visual warnings of the incorrect ground vehicle presence in the runway and prevented the runway incursion incident.

Assuming you are one of the Safety Inspector from Civil Aviation Authority, perform an internal investigation with the information provided above in accordance with the following steps:

- a) Gather facts and chain events (sequential events from initiating event to incident realization) that led to the runway incursion. (20 marks)
- b) Identify contributing safety factors. (10 marks)
- c) Based on the causal factors, provide a safety recommendation that would solve or alleviate the problem. Target your recommendation at an organisation or company that is empowered to take the action. (20 marks)

**TASHI DELEK**