

**ROYAL CIVIL SERVICE COMMISSION  
BHUTAN CIVIL SERVICE EXAMINATION (BCSE) 2019  
EXAMINATION CATEGORY: TECHNICAL**

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

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<b>Date</b>	: October 13, 2019
<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 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 in 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 are required to hand over the Answer Booklet to the Invigilator before leaving the examination hall.**
10. This paper has **10 printed pages**, including this instruction page.

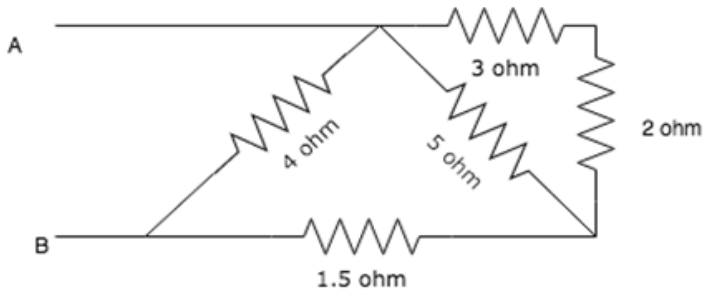
**GOOD LUCK**

**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. Dihedral wing increases
  - a) longitudinal stability.
  - b) lateral stability.
  - c) direction stability.
  - d) None of the above.
  
2. Calculate the equivalent resistance between A and B.



- a) 2 ohm
  - b) 4 ohm
  - c) 6 ohm
  - d) 8 ohm
- 
3. The binary number 10101 is equivalent to decimal number \_\_\_\_\_.
    - a) 19
    - b) 12
    - c) 27
    - d) 21
  
  4. In a pnp transistor, the current carriers are \_\_\_\_\_.
    - a) acceptor ions
    - b) donor ions
    - c) free electrons
    - d) holes
  
  5. Slow plastic deformation of metals under a constant stress is known as
    - a) Creep
    - b) Fatigue
    - c) Endurance
    - d) Plastic deformation

6. Which of the following instruments does NOT use the pitot-static probe for its input?
  - a) Airspeed indicator
  - b) Altitude indicator
  - c) Vertical speed indicator
  - d) Attitude indicator
  
7. In turbofan engine, the bypass ratio is the ratio of
  - a) total mass flow rate of exhaust stream to the mass flow rate of stream from turbine exhaust.
  - b) total mass flow rate of exhaust stream to the mass flow rate of stream from fan exhaust.
  - c) the mass flow rate of stream from turbine exhaust to the mass flow rate of stream from fan exhaust.
  - d) the mass flow rate of stream from fan exhaust to the mass flow rate of stream from turbine exhaust.
  
8. What happens to the buoyant force acting on the airship as it rises in the air?
  - a) Buoyant force increases.
  - b) Buoyant force decreases.
  - c) Buoyant force remains constant.
  - d) Buoyant force first increases then shows decrease.
  
9. The transfer of heat between a wall and a fluid system in motion is called
  - a) Radiation
  - b) Convection
  - c) Conduction
  - d) Evaporation
  
10. Which philosophy adheres to the concept whereby no single structure supports the entire load?
  - a) Damage tolerant structure
  - b) Fail-safe structure
  - c) Monocoque structure
  - d) Semi-monocoque structure
  
11. Bernoulli's equation shows that
  - a) at constant velocity, the kinetic energy of the air changes with a change of height.
  - b) with a change in velocity at constant height, the static pressure will change.
  - c) with a change in speed at constant height, both kinetic and potential energies change.
  - d) at constant kinetic energy, the velocity of the air changes with a change of height.
  
12. A piezoelectric device generates electricity through
  - a) friction.
  - b) light.
  - c) pressure.
  - d) All of the above.

13. What gate does the following Boolean expression represent  $F = A.B.C$ .
- AND
  - OR
  - NOT
  - None of the above.
14. On a modern 'glass cockpit' aircraft, engine information will be displayed on
- FMS
  - EFIS
  - ECAM
  - ECU
15. Nitriding is
- tempering.
  - anodising.
  - case hardening.
  - None of the above
16. The most appropriate fire extinguisher for an aircraft wheel and brake fire would be
- carbon dioxide.
  - dry powder.
  - water.
  - foam.
17. Human Circadian rhythms cycle on a
- 25 hour timescale.
  - 8 hour timescale.
  - 24 hour time scale.
  - 6 hour time scale.
18. The purpose of a slot in a wing is to
- speed up the airflow and increase lift.
  - act as venturi, accelerate the air and re-energize boundary layer.
  - provide housing for the slat.
  - increase the stall speed.
19. In semi-monocoque construction, compression loads are taken by
- stringers.
  - bulkheads.
  - frames.
  - skin.
20. In a free turbine:
- there is a clutch between compressor and power output shaft.
  - there is a direct drive with a free-wheel unit.
  - there is no mechanical connection with the compressor.
  - None of the above.

21. What type of equation is this?  $ax^2 + bx + c = 0$ .
- Quadratic equation.
  - Polynomic equation.
  - Gradient of the line.
  - Linear
22. The centre of gravity of an aircraft is adjusted by two weights, 10 kg and 5 kg placed 4m and 2 m aft of the c of g. To what position must a 20 kg weight be added to balance the c of g?
- 2.5m
  - 4m
  - 2m
  - 0.33m
23. A pressure gauge is fitted to a Dead Weight Tester. The piston area is 0.25 sq.in. and the total mass of the mass carrier and masses is 5lb. If the pressure gauge is accurate, what pressure in pounds per square inch (PSI) will it read?
- 1.25 psi.
  - 20 psi.
  - 200 psi.
  - 05 psi
24. Which of the following gate is a two-level logic gate?
- OR gate
  - NAND gate
  - EXCLUSIVE OR gate
  - NOT gate
25. A NAND gate is called a universal logic element because
- it is used by everybody.
  - any logic function can be realized by NAND gates alone.
  - all the minimization techniques are applicable for optimum NAND gate realization.
  - many digital computers use NAND gates.
26. Tolerance is
- the difference between a hole and shaft size.
  - allowable error due to faulty workmanship and tools.
  - difference between worn and new tools.
  - same as Allowance.
27. At what point in an axial flow turbojet engine will the highest gas pressures occur?
- At the compressor outlet.
  - At the turbine entrance.
  - Within the burner section.
  - At the exhaust outlet.

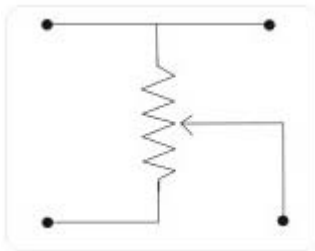
28. What controls pitch and roll on a delta wing aircraft?

- a) Elevators
- b) Ailerons
- c) Elevons
- d) Rudder

29. What frequency range does ACARS operate in?

- a) 2-30 MHz
- b) 118-136 MHz
- c) 4-5 GHz
- d) 88.1-108.1 MHz

30. This is a diagram of a



- a) potentiometer.
- b) variable resistor.
- c) rheostat.
- d) voltage regulator.

**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.**

1. a) Most drawings of a technical nature are drawn in standard 2D formats. This is a universally accepted practice and understood by engineers across the world. There are however occasions when further views are required, to give a better perspective of the shape of the item or part of the item. In this regard, there are many methods of illustration.
    - i. What do you understand by Orthographic Projection Drawings? (1 mark)
    - ii. Name three types of Pictorial Drawings frequently used by engineers. (1 mark)
  - b) A pentagonal prism with side of base 25mm and axis 50mm long is resting on its base on HP such that one of its rectangular faces is parallel to VP and 10mm away from it. Draw the projections of the prism. (3 marks)
2. a) A die is rolled, find the probability that an odd number is obtained. (2 marks)

- b) In Paro International Airport, on an average 10 incident of bird strike with aircraft is reported annually. Calculate the probability of  $k = 0, 5,$  and  $15$  bird strike in a year interval, assuming the Poisson model is appropriate. (3 marks)
3. a) Consider an arbitrary number system with the independent digits as  $0, 1$  and  $M$ .
- What is the radix of this number system? (1 mark)
  - List the first 10 numbers in this number system. (1 mark)
- b) Draw a circuit diagram corresponding to the following Boolean expression:  
 $A'B + (B+C)'$  (3 marks)
4. a) An Aircraft X with elliptical wing was registered in Bhutan and made its maiden flight in Bhutanese airspace in 1997. Its maximum speed at 18,500 ft altitude was 362 mi/h. Its weight was 5820 lb, wing area 242 ft<sup>2</sup> and wing span 36.1 ft. Calculate the induced drag coefficient at this flight condition.  
(At this altitude, density  $\rho = 0.0013329$  slug/ft<sup>3</sup>, also assume  $\tau = \delta$ ). (4 marks)
- b) You wish to determine the relevant dimensionless groups for a problem involving measurement of the lift generated by the incompressible flow past a given aerofoil profile. You believe that the relevant variables associated with this problem are as follows:

Symbol	Definition (units)
$\alpha$	Angle of incidence (radian)
$V_\infty$	Freestream velocity (m/s)
$c$	Aerofoil chord length (m)
$\rho$	Air density (kg/m <sup>3</sup> )
$\mu$	Air dynamic viscosity (N.s.m <sup>-2</sup> )
$L$	Lift per unit span (N/m)

How many unique fundamental dimensions are represented amongst these variables? (1 mark)

**SECTION B: Case Study (50 marks)**

**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**

Approximately 80 percent of airplane accidents are due to human error (pilots, air traffic controllers, mechanics, etc.) and 20 percent are due to machine (equipment) failures. Aviation Human Factors is the silent relationship that exists between the person, machine and environment. Understanding this intangible relationship is often the key to determining the causation on an accident.

Human factors are issues affecting how people do their jobs. They are the social and personal skills, such as communication and decision making which complement our technical skills. These are important for safe and efficient aviation.

The study of human factors involves applying scientific knowledge about the human body and mind to help understand human capabilities and limitations. Human factors knowledge can be used to reduce the likelihood of errors and build more error tolerant and more resilient systems.

In this regard answer the following:

1. Define:
  - a) Aircraft accident (2 marks)
  - b) Aircraft Incident (2 marks)
  - c) Aircraft Serious Incident (2 marks)
  
2. Explain any **TWO** of the following Error Model: (8 marks)
  - a) PEAR Model
  - b) SHELL Model
  - c) The James REASON 'Swiss cheese' model
  - d) The Dirty Dozen (Gordon Dupont) – Taxonomy of errors
  
3. Classify these following aviation incidents as ERROR or Violation: (4 marks)
  - a) Failure to follow published technical data or local instructions.
  - b) Inattention to detail/complacency.
  - c) Incorrectly installed hardware on an aircraft/engine.
  - d) Performing an unauthorized modification to the aircraft.
  
4. Aviation personnel need to be mindful of many human and environmental factors to minimize human error and prevent aviation incidents or accidents. Name and briefly explain at least:
  - a) Two human performance and limitation factors. (10 marks)
  - b) Two Environment factors. (10 marks)



5. Concept of Deming Wheel and feedback system is paramount in any aviation product and organisation to ensure aviation safety and continuous organizational improvement.

Briefly explain the following system integrated in aviation organisation:

- a) Quality Management system (4 marks)
- b) Safety Management System (4 marks)
- c) Occurrence reporting System (4 marks)

## **CASE II**

Assuming you are one of the investigator to investigate the aircraft accident, please read the accident scenario below of the runway overrun accident at Anytown City Airport and Identify and list down what are the:

1. Active failures – factors directly causing the accident. (20 marks)
2. Latent failures – pre-conditions that were hidden within the system that indirectly contributed to the accident. (15 marks)
3. Latent failures that existed at the decision-making and line management level. (15 marks)

### **Anytown City Airport Accident Scenario:**

1. In the late hours of a summer Friday evening, while landing on a runway heavily contaminated with water, a twin-engine jet transport aircraft with four crew members and 65 passengers on board overran the westerly end of the runway at Anytown City airport. The aircraft came to rest in the mud a short distance beyond the end of the runway. There were no injuries to crew or passengers, and there was no apparent damage to the aircraft as a consequence of the overrun. However, a fire started and subsequently destroyed the aircraft.
2. Anytown City is a popular summer resort. The predominant weather for a typical summer day is low stratus and fog in the early morning, which gradually develops into convective cloud as the air warms. Severe thunderstorms are common in the early afternoon and persist until the late evening hours. The whole region where Anytown City is situated is “thunderstorm country” during summer.
3. The runway at Anytown is 4,520 feet long. It is a relatively wide runway with a steep downward slope to the west. The runway has poor construction and paving, and has lack of adequate drainage during rainy season. It is served by a low-power, short-range, non-directional beacon (NDB), unreliable in convective weather. Runway lighting is low-intensity, and there are no approach lights or visual approach aids. It is a classic “black-hole” approach during night landings. These were reported on numerous occasions by previous flight crew but no attempt was made to rectify the problem.

4. The flight had originated at the airline's main base, 400 km away. This was the second-to-last flight for the flight crew that day. They had reported for duty at 1130 hours and were due to be relieved at 2200 hours. The crew had been flying a different schedule for the last three weeks. This was the beginning of a new four-day schedule on another route. It had been a typical summer afternoon, with thunderstorms throughout the entire region. Anytown City had been affected by thunderstorms during the early afternoon. No forecast was available, and the captain had elected to delay the departure.
5. The flight schedule was very tight working on a turnaround time of 15 minutes, and the captain's decision to delay created a number of additional delay for subsequent flights. The dispatcher working the flight did not bring to the flight crew's attention the need to consider a contaminated runway operation at Anytown, and did not review the landing performance limitations with them. After a long delay, the captain decided to add contingency fuel and depart.
6. Visual conditions were present at Anytown, although there were thunderstorms in the vicinity of the airport, as well as a persistent drizzle. With no other reported traffic, they were cleared for a night visual approach. After touchdown, the aircraft hydroplaned and overran the end of the runway slightly above taxiing speed.
7. The captain was a very experienced pilot. He had been with the airline for many years, accumulating several thousand hours of flying time as a first officer in two other types of large jet aircraft. However, he had limited experience with the aircraft type he was flying on the night of the accident. He had not had the occasion to fly into Anytown before because the larger aircraft types he had been flying previously did not operate into Anytown. This was his first month as a captain. He was a well-balanced individual, with no personal or professional behavioural extremes.
8. At the time of the accident the first officer was very inexperienced. He had recently been hired by the airline and had only been flying on the line for about a month. He had flown into Anytown on two other occasions with another captain, but only during the day. His training records indicated standard performance during induction into the airline's operations.

**TASHI DELEK**