ROYAL CIVIL SERVICE COMMISSION
BHUTAN CIVIL SERVICE EXAMINATION (BCSE) 2018
EXAMINATION CATEGORY: TECHNICAL

PAPER III: SUBJECT SPECIALISATION PAPER FOR MECHANICAL ENGG.

Date	: 7 October 2018
Total Marks	: 100
Writing Time	: 150 minutes (2.5 hours)
Reading Time	: 15 minutes (prior to writing time)

GENERAL INSTRUCTIONS:

1. Write your Registration Number clearly and correctly on the Answer Booklet.
2. The first 15 minutes is being provided to check the number of pages, printing error, clarify doubts and to read instructions in Question Paper. You are NOT permitted to write during this time.
3. This paper consists of **TWO Sections, namely Section A and 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 2 case studies. Choose only **ONE** case study and answer the questions under 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 correct 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. The Question paper has **8 printed pages,** including this Instruction Page.

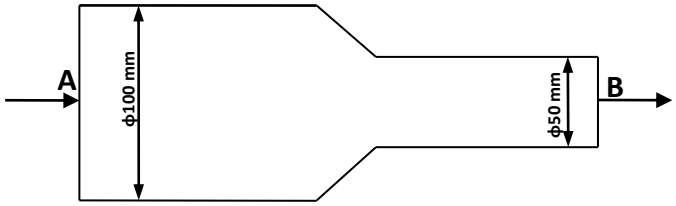
GOOD LUCK

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 (c). Each question carries ONE mark. Any double writing, smudgy answers or writing more than one choice shall not be evaluated.

1. In the pipe shown below, if a fluid of $\rho=800kg/m^3$ is pumped from the end A with an average velocity of 0.5 m/s, it will come out at end B with an average velocity of _____ if there is no accumulation.



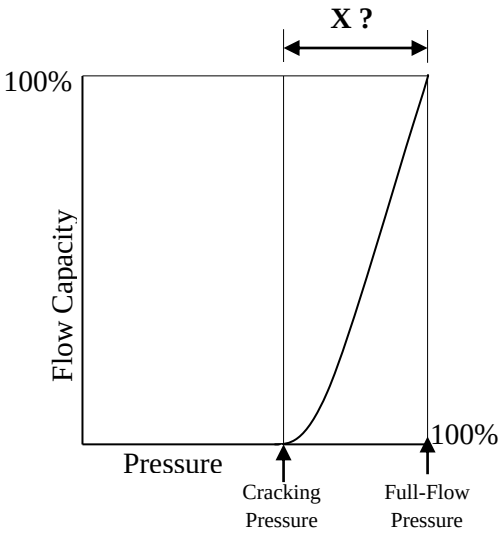
   a) 1 ms^{-1}
   b) 2 ms^{-1}
   c) 3 ms^{-1}
   d) 4 ms^{-1}

2. The air-fuel ratio necessary to achieve complete combustion is known as
   a) Stoichiometric ratio
   b) Lean fuel mixture
   c) Calorific ratio
   d) Combustion ratio

3. A screw is said to be self locking or overhauling screw if its efficiency is
   a) =50% or <50% respectively
   b) >50% or <50% respectively
   c) >50% or =50% respectively
   d) < 50% or >50% respectively

4. The castings produced by forcing molten metal under pressure into a permanent metal mould is known as:
   a) Slush casting
   b) Die casting
   c) Permanent mould casting
   d) Centrifugal casting

5. The diagram shows the pressure Vs flow capacity graph of a relief valve in a hydraulic control system. What is "X" ?
   a) Actuation pressure
   b) Pressure drop
   c) Flow pressure
   d) Pressure override



6. _____ are most commonly used for pneumatic control applications.
   a) Centrifugal compressors
   b) Turbo compressors
   c) Positive displacement compressors
   d) Negative displacement compressors

7. Flywheel arms will be subjected to tensile stress due to:
   a) Fluctuation of energy
   b) Centrifugal force acting on the rim
   c) Storage of energy
   d) Centripetal force acting on the rim

8. When there is a variation of load, engine speed is maintained within specified limits by:
   a) Governor
   b) Dynamometer
   c) Flywheel
   d) Clutch

9. If two shafts are made of same materials and diameter of one shaft is half of the other, power transmitted by the smaller diameter shaft will be _____ of the larger shaft.

   a) $\frac{1}{2}$

   b) $\frac{1}{4}$

   c) $\frac{1}{8}$

   d) $\frac{1}{16}$

10. An electromechanical energy convertor that converts chemical energy of fuel directly into DC electricity is called:
    a) Combustion Engine
    b) Fuel Generator
    c) Fuel Cell
    d) DC Generator

11. In spur gears, the product of diametral pitch and circular pitch is equal to:
    a) Number of teeth × π
    b) $\frac{1}{\pi}$
    c) 1
    d) π

12. The factor of safety for ductile materials is based on:
    a) Compressive strength
    b) Tensile strength
    c) Ultimate strength
    d) Yield strength

13. The ratio of power produced by the turbine runner to the power supplied by water at the turbine inlet is called:
    a) Volumetric efficiency
    b) Mechanical efficiency
    c) Hydraulic efficiency
    d) Overall efficiency

14. In maintenance engineering, MTTR stands for:
    a) Mean Time To Repair
    b) Minimum Time To Repair
    c) Maximum Time To Repair
    d) Moderate Time To Repair

15. The angular velocity of a shaft revolving at 120rpm is:
    a) 12.57 meter per second
    b) 12.57 rpm
    c) 12.57 radian per second
    d) 12.57 degree

16. The specific weight of one litre of a liquid weighing 7 Newton is:
    a) 700 Kg/m^3
    b) 7000 Kg/m^3
    c) 700 N/m^3
    d) 7000 N/m^3

17. If the pressure difference between the inside and outside of a soap bubble of 4mm diameter is 10 N/m^2, the surface tension is:
    a) 0.01 N/m
    b) 0.10 N/m
    c) 1.0 N/m
    d) 10 N/m

18. The pressure relative to the atmosphere as indicated by most instrument is called:
    a) Absolute pressure
    b) Gauge pressure
    c) Atmospheric pressure
    d) Vacuum pressure

19. The modulus of elasticity for mild steel is approximately equal to:
    a) 2.1×10^6 kgf/cm^2
    b) 0.8×10^6 kgf/cm^2
    c) 1.1×10^6 kgf/cm^2
    d) 0.1×10^6 kgf/cm^2

20. As per the law of gravitation, the force of attraction between two bodies of masses 1Kg each separated by a distance of 1m is:
    a) 6.67×10^{-11}N
    b) 6.67×10^{11}N
    c) 66.70×10^{-11}N
    d) 66.70×10^{11}N

21. The force of gravitation between two bodies will be inversely proportional to the square of the distance between their centre of masses if the bodies are:
    a) of constant densities.
    b) symmetrical about their centres of mass.
    c) of any arbitrary shape.
    d) of same shape, sizes and orientation.

22. The crankshaft in an internal combustion engine:
    a) is a disc which reciprocates in a cylinder.
    b) is used to retain the working fluid and to guide the piston.
    c) converts reciprocating motion of the piston into rotary motion and vice versa.
    d) is manufactured by TIG welding.

23. The heating and expanding of a gas is called
    a) thermodynamic system
    b) thermodynamic cycle
    c) thermodynamic process
    d) thermodynamic law

24. _____ is most commonly used in nuclear power plants:
    a) Nuclear fusion reaction
    b) Nuclear fission reaction
    c) Nuclear decay
    d) Nuclear transmutation

25. In power plant engineering:
    a) Load factor x Use factor = Capacity factor
    b) Capacity factor x Use factor = Load Factor
    c) Load factor x capacity factor = Use factor
    d) Capacity factor x Load factor x Use factor = 1

26. The magnitude of a vector quantity is:
    a) The dot product of the vector with itself.
    b) The dot product of the vector with unit vector along itself.
    c) The cross product of the vector with unit vector along itself.
    d) The cross product of the vector with itself.

27. A free body diagram of a body shows a body:
    a) isolated from all external effects.
    b) isolated from its surroundings and all external actions acting on it.
    c) isolated from its surroundings and all external forces acting on it.
    d) separately from its surroundings and all external and internal forces acting on it.

28. The resistance per unit area offered by a body against deformation is known as:
    a) Strain
    b) Stress
    c) Elasticity
    d) Elongation

29. ASTM stands for:
    a) American Society of Testing and Materials
    b) American Standards for Testing and Materials
    c) Australian Society of Testing and Materials
    d) Australian Standards for Testing and Materials

30. The most common type of nuclear reactor used in the world is:
    a) Pressurised water reactor
    b) Boiling water reactor
    c) Pressurised heavy water reactor
    d) Gas-cooled reactor

PART II – Short Answer Questions (20 marks).

This part has 4 Short Answer Questions. Answer ALL the questions. Each question carries 5 marks.

1. A wrought iron bar of 50mm in diameter and 2.5m long transmits shock energy of 100 N-m. Find the maximum instantaneous stress and elongation. Take E = 200 GN/m^2. (5 marks)

2. A gas expands from pressure p_1 to pressure p_2 which is $\frac{p_1}{10}$. If the process of expansion is isothermal, the volume at the end of expansion is 0.55 m^3. If the process of expansion is adiabatic, estimate the volume at the end of expansion. Take $\gamma = 1.4$. (5 marks)

3. (a) Define thick and thin cylinders. Give at least one example each. (2.5 marks)
   (b) State three issues of concern on the debate against nuclear power plant. (2.5 marks)

4. A welded platform top is made by 20mm steel plates requiring 10 joints of 1 metre length each. The welding is done from one side only using semi-automatic submerged arc welding set using 4 S.W.G electrodes. The labour charges are Nu. 150 per hour. The length of electrode required per metre run is 2.5 metres and costs Nu. 25 per metre. Power consumption is 6 kWh per metre of weld and the power costs Nu. 2 per kWh. The time required for welding 1 metre length is 20 minutes. Calculate the total cost of welding. Consider the following: (5 marks)
   i. Overhead charges = Nu. 5 per hour.
   ii. Loss of electrode due to sputter and vaporisation = 5%.
   iii. Fatigue allowance for labour charges = 30%.

SECTION B

Case Study

Choose either Case I OR II from this section. Each case study carries 50 marks.

Case I

Machine design deals with creation of new and better machines and improvement of the existing ones. New and better machines are expected to be more economical in the overall cost of production and operation. Therefore, engineers need to consider numerous factors while designing any machines and mechanical systems. In this context, describe the following in detail.

- Classification of machine design
- Different phases of design

- General considerations in machine design
- General procedures in machine design
- New and emerging practices in machine design
- Responsibilities of a professional mechanical design engineer

Case II

Maintenance of plant and equipment is one of the important responsibilities of mechanical engineers working in power plants. If you are appointed as the Head of Maintenance Department of a Hydroelectric Power Plant, how will you address the maintenance to optimise the operation of the plant? Present your proposal on how you will organise and carry out the much needed maintenance functions. You are expected to analyse different types of maintenance and maintenance strategies applicable for hydropower plants and discuss on how they will be implemented so that the plant downtime is minimised and power generation is maximised.

TASHI DELEK