ROYAL CIVIL SERVICE COMMISSION
BHUTAN CIVIL SERVICE EXAMINATION (BCSE) 2012
EXAMINATION CATEGORY: TECHNICAL

PAPER III: SUBJECT SPECIALIZATION PAPER for MECHANICAL ENGINEERING

Date	: 14 October 2012
Total Marks	: 100
Examination Time	: 150 minutes (2.5 hours)
Reading Time	: 15 Minutes (prior to examination time)

READ THE FOLLOWING INSTRUCTIONS CAREFULLY:

1. Write your Roll Number clearly on the Answer Booklet in the space provided.
2. The first 15 minutes is being provided to check the number of pages, printing errors, clarify doubts and to read the instructions. You are NOT PERMITTED TO WRITE during this time.
3. Use either Blue or Black ink pen or ball point pen for the written part and Pencils for the sketches and drawings.
4. All answers should be written on the Answer Booklet provided. Candidates are not allowed to write anything on the question paper or any other materials.
5. It is divided into two sections-namely SECTION A and SECTION B.
6. SECTION A consists of two parts: Part I and Part II.

   Part I consists of 30 Multiple-Choice Questions carrying one (1) mark each and is compulsory. The answer of your choice should be clearly written in whole along with the question and option number on your answer booklet. Eg. 31(c).

   Part II consists of four (4) short answer questions of five (5) marks each and all questions are compulsory. Mark for each sub-question is indicated in the brackets.

7. SECTION B consists of two Case Studies. Choose only ONE case study and answer the questions under your choice. Each case study carries fifty (50) marks in total. Mark for each sub-question is indicated in the brackets.
8. This Paper consists of TEN (10) pages including this Instruction page.

SECTION A (50 Marks)

Answer all questions.

I. Multiple Choice Questions (30 Marks).

Each question carries 1 (one) mark. Write the question number followed by answer of your choice on the answer sheet.

1. A bolt of M24 x 2 means
   a. The pitch of the thread is 24mm and depth is 2mm
   b. Cross-sectional area of the thread is $24mm^2$
   c. Nominal diameter of the bolt is 24mm and the pitch is 2mm
   d. The effective diameter of the bolt is 24mm and there are 2 threads per cm

2. Hooke's law holds good up to
   a. Yield point
   b. Elastic limit
   c. Plastic limit
   d. Breaking point

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

4. _____ is considered as the "Father of Engineering Economics".
   a. O.B Goldman
   b. J.C.L Fish
   c. Arthur M. Wellington

d. Eugene L. Grant

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

6. According to Indian standard specification, 100 H6/g5 refer to
   a. Tolerance grade of 6 for the hole and 5 for the shaft
   b. Tolerance grade of 6 for the shaft and 5 for the hole
   c. Tolerance grade of 11 for the hole
   d. Tolerance grade of 11 for the shaft

7. The modulus of elasticity for mild steel is approximately equal to
   a. 0.1 x 106 kgf/cm^2
   b. 0.8 x 106 kgf/cm^2
   c. 1.1 x 106 kgf/cm^2
   d. 2.1 x 106 kgf/cm^2

8. In case of a multiple disc clutch, if $\mathbf{n_1}$ are the number of discs on the driving shaft and $\mathbf{n_2}$ are the number of discs on the driven shaft, the number of pairs of contact surfaces will be
   a. $n_1 + n_2$
   b. $n_1 - n_2$
   c. $n_1 + n_2 - 1$
   d. $n_1 + n_2 + 1$

9. Due to the centrifugal force acting on the rim, the flywheel arms will be subjected to
   a. Tensile stress
   b. Compressive stress

c. Shear stress

d. Torsion stress

10. A brake commonly used in motor cars is

a. Shoe brake

b. Band brake

c. Band and block brake

d. Internal expanding brake

11. The size of the gear is usually specified by

a. Pressure angle

b. Pitch circle diameter

c. Circular pitch

d. Tooth thickness

12. Steel containing up to 0.15% carbon is known as

a. Mild steel

b. Dead mild steel

c. Medium carbon steel

d. High carbon steel

13. Steel widely used for motor car crankshaft is

a. Nickel-chrome steel

b. Chrome steel

c. Silicon steel

d. Nickel steel

14. The maximum bending stress in a curved beam having symmetrical section always occur at the

a. Centroidal axis

b. Neutral axis

c. Inside fibre

d. Outside fibre

15. Rankine's theory is used for
    a. Brittle materials
    b. Ductile materials
    c. Elastic materials
    d. Plastic materials

16. The design of pressure vessel is based on
    a. Longitudinal stress
    b. Hoop stress
    c. Tangential stress
    d. Torsional stress

17. Which of the following joints is commonly used for pipes carrying water at low pressure
    a. Union joint
    b. Spigot joint and socket
    c. Nipple joint
    d. Socket or a coupler joint

18. A leaf spring is used in automobiles to
    a. Apply forces
    b. Measure forces
    c. Store strain energy
    d. Absorb shocks

19. A key made from cylindrical disc having segmental cross-section is known as
    a. Tangential key
    b. Woodruff key
    c. Feather key
    d. Flat saddle key

20. The maximum shear stress theory and maximum normal stress theory are used for

a. Brittle and plastic materials respectively
b. Brittle and ductile materials respectively
c. Ductile and brittle materials respectively
d. Plastic and non-ferrous materials respectively

21. In levers, leverage is the ratio of

a. Load lifted to the effort applied
b. Mechanical advantage to velocity ratio
c. Load arm to effort arm
d. Effort arm to load arm

22. Slenderness ratio is the ratio of

a. Maximum size of a column to minimum size of a column
b. Width of column to depth of column
c. Effective length of column to least radius of gyration of the column
d. Effective length of column to width of column

23. Which of the following screw is adopted for power transmission in either direction?

a. Acme threads
b. Square threads
c. Buttress threads
d. Multiple threads

24. 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

25. The included angle for the V-belt is usually
    a. $20^{\circ} - 30^{\circ}$
    b. $30^{\circ} - 40^{\circ}$
    c. $40^{\circ} - 60^{\circ}$
    d. $60^{\circ} - 80^{\circ}$

26. A spring used to absorb shocks and vibration is
    a. Conical spring
    b. Helical spring
    c. Leaf spring
    d. Disc spring

27. In thrust bearings, the load acts
    a. Along the axis of rotation
    b. Parallel to the axis of rotation
    c. Perpendicular to the axis of rotation
    d. Opposite to the axis of rotation

28. If "d" is the diameter of the workpiece, "n" is the number of revolutions of the workpiece, the cutting speed "v" for the turning operation is given by
    a. $v = \frac{\pi dn}{2}$
    b. $v = \pi dn$
    c. $v = \frac{\pi d}{n}$
    d. $v = \frac{n}{\pi d}$

29. In Oxy-Acetylene welding process, reducing flame is produced when
    a. Equal volumes of oxygen and acetylene are mixed in the welding torch and burnt at the torch tip
    b. The supply of oxygen to the neutral flame is increased
    c. The supply of oxygen to the neutral flame is decreased

d. The supply of acetylene to the neutral flame is decreased

30. Number of revolutions of crankshaft required for a four stroke engine is

a. 1

b. 2

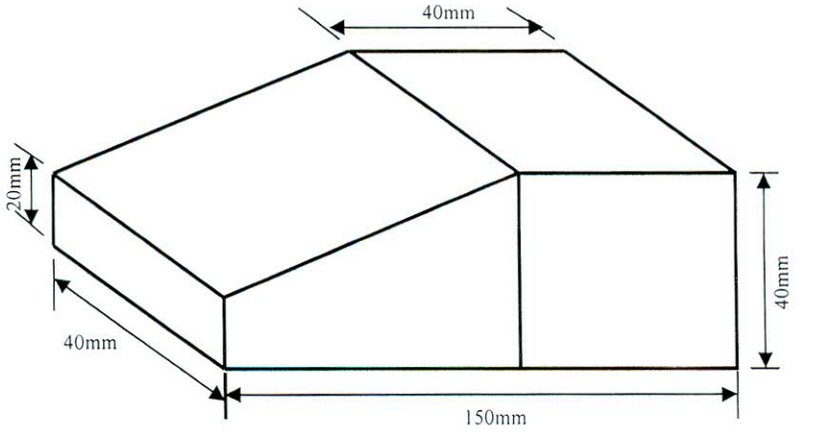
c. 4

d. 8

II. Short answer questions (20 Marks).

Each question carries 5 marks. Write the question number followed by answer on the answer sheet.

1. What are the different types of turbines used in hydropower plants? Give two characteristic factors used for the selection of turbine.
2. Draw a valve timing diagram for a four stroke engine with clear labels and explain the terms lead, lag and overlap in relation to it.
3. A hydraulic press exerts a total load of 3.5×10^6N. This load is carried by two steel rods of equal diameters, supporting the upper head of the press. If the safe stress is $85 N/mm^2$ and $E = 210\ kN/mm^2$, calculate the diameter of each rods.
4. The following wedge is to be made from ϕ50mm bar stock by forging. Calculate length of bar stock required if the volume of the metal remains unchanged.



SECTION B (50 Marks)

Following are 2 (two) case studies and candidates are required to attempt only 1 (one).

This case study carries 50 Marks.

1. During the 15th Session of Conference of Parties (COP15) of the United Nations Framework Convention on Climate Change (UNFCCC) in Copenhagen in 2009, the Royal Government of Bhutan (RGOB) committed to remain carbon neutral, ensuring that the Country's greenhouse gas (GHG) emissions will remain less than the sequestration capacity of its forests for all times. Bhutan has good hydropower potential, an environmentally clean source of energy relieving the Country from fears of enormous emissions otherwise likely from consumption and utilization of unsustainable energy which is the case with high emitting countries. However, transportation is the sector in the Country which is completely dependent on fossil fuel; a highly emission intensive energy source. Accordingly, the Economic Development Policy 2010 of RGOB has identified reduction in dependency on fossil fuel especially in transportation as one of the strategies for low emission development in the Country. The particular strategy requires planning and implementation of environmentally sustainable transport system. In this regard, introduction of **hydrogen economy** is felt appropriate and timely in an effort to reducing dependency on fossil fuel and saving the Country from adverse impact of climate change.

   As a Mechanical Engineer of the Modern World concerned with environmental sustainability of engineering solutions, you are proposing a project titled **"DNH for GNH"** meaning **"Driving the Nation with Hydrogen for Gross National Happiness"** to the RGOB, a project on introducing sustainable transport in Bhutan which will adopt hydrogen fuel cell technology for vehicles. Describe the proposed technology and infrastructures required to be established for the successful implementation of the project. What edge does Bhutan have in implementing such project and how will it contribute to Carbon Neutral Policy of RGOB.

OR

2. Bhutanese textiles have inherent intricacy in design that has been achieved only through traditional weaving skill so far. Duplicate designs are produced and available in the market at cheap prices but they lacked several qualities that are achieved by traditional weaving. However,

traditional weaving is laborious, strenuous and time consuming. Besides these drawbacks, not all Bhutanese have the requisite skills in traditional weaving. Moreover, it is not favourable for mass production because of which original Bhutanese woven textiles are expensive and unaffordable to many. As a result, the Country depends on import of textiles, even for the main clothing needs i.e. Ghos and Kiras besides other apparels. If Bhutanese textiles are to be made cheaper and affordable to all, following should be addressed besides facilitating trainings on skills development.

- Time consumption should be reduced
- Weaving should be made less laborious and less strenuous
- Designs should be made easily replicable but indigenous intricacy should be maintained.

In this regard, it is felt that introduction of appropriate technology will address the above drawbacks/issues and make traditional Bhutanese weaving favourable for mass production and make products cheaper than today. This would also generate immense employment opportunities for Bhutanese women.

As a Mechanical Engineer, how will you revolutionise the Bhutanese traditional weaving method with the introduction of modern technology. Present your proposal.