ROYAL CIVIL SERVICE COMMISSION
BHUTAN CIVIL SERVICE EXAMINATION (BCSE) 2013
EXAMINATION CATEGORY: TECHNICAL

PAPER III: SUBJECT SPECIALIZATION PAPER for *MECHANICAL ENGINEERING*

Date	: 14 October 2013
Total Marks	: 100
Examination Time	: 150 minutes (2.5 hours)
Reading Time	: 15 Minutes (prior to examination time)

GENERAL INSTRUCTIONS:

1. Write your Roll Number clearly and correctly on the Answer Booklet.
2. The first 15 minutes is being provided 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 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 two Case Studies. Choose only ONE case study and answer the questions under your choice.
4. 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 any or correct Section, Part and Question Number will NOT be evaluated and no marks would be awarded.
5. Begin each Section and Part in a fresh page of the Answer Booklet.
6. You are not permitted to tear off any sheet(s) of the Answer Booklet as well as the Question Paper.
7. Use of any other paper including paper for rough work is not permitted.
8. You are required to hand over the Answer Booklet to the Invigilator before leaving the examination hall.
9. This paper has **08** printed pages in all, 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 the correct answer chosen 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. Flywheel arms will be subjected to tensile stress due to:
   a. Centrifugal force acting on the rim
   b. Centripetal force acting on the rim
   c. Fluctuation of energy
   d. Storage of energy

2. Kinematic viscosity of a fluid is defined as:
   a. The viscosity of the fluid in motion
   b. The ratio of dynamic viscosity to mass density
   c. The ratio of static viscosity to mass density
   d. The viscosity of fluid in static condition

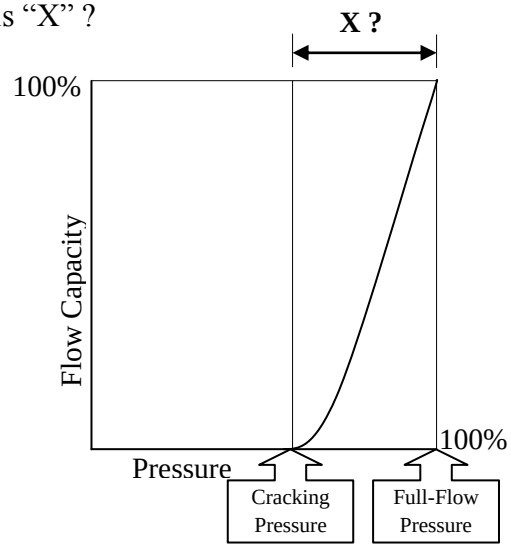
3. Worm gears are widely used for transmission of power:
   a. Between shafts of same diameter
   b. Between shafts of extremely large diameter
   c. Between non-intersecting shafts
   d. Between Intersecting shafts

4. 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. Half
   b. One-fourth
   c. One-eighth
   d. One-sixteenth

5. Slow and progressive deformation of a material with time under a constant stress is called:
   a. Creep
   b. Resilience
   c. Toughness
   d. Elasticity

6. A plant produces 200 parts per shift of 8 hours. If the standard time to produce a part is 2 minutes, the productivity of the plant is:
   a. $\frac{5}{6}$
   b. $\frac{6}{5}$
   c. $\frac{1}{4}$
   d. $\frac{2}{25}$

7. 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 override
   c. Pressure drop
   d. Flow pressure



8. In rear wheel drive vehicles with a 4:1 gear ratio in the final drive:
   a. Rear wheels would turn four times to turn the front wheels once
   b. Propeller shaft would turn four times to turn the rear wheels once
   c. One turn of propeller shaft would turn the rear wheels four times
   d. One turn of rear wheels would turn the front wheels four times

9. For mechanical power transmission between two shafts of smaller distances:
   a. Belt drives are preferred
   b. Gear drives are preferred
   c. Chain drives are preferred
   d. All above drives are equally preferred

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

11. If the number of teeth of a spur gear is 30 and has a module of 2mm, its circular pitch will be:
    a. 2
    b. 2π
    c. $\frac{30}{\pi}$
    d. $\frac{15}{2\pi}$

12. For ductile materials, the factor of safety is based on:
    a. Tensile strength
    b. Ultimate strength
    c. Yield strength
    d. Compressive strength

13. The network model PERT stands for:
    a. Project Evaluation and Review Technique
    b. Programme Evaluation and Research Tool
    c. Programme Evaluation and Review Technique
    d. Project Evaluation and Review Tool

14. Strain energy per unit volume required to stress the material from zero stress to yield stress is called:
    a. Modulus of elasticity
    b. Modulus of resilience
    c. Modulus of toughness
    d. Modulus of stress

15. In the ideal gas equation, PV=nRT, "n" is the:
    a. Number of molecules
    b. Quantity in moles
    c. Molecular weight
    d. Avogadro number

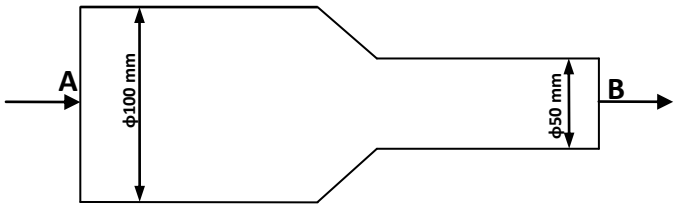
16. If a job of diameter "D" cm is revolving at a speed of "N" r.p.m, cutting speed is computed as:
    a. $\frac{\pi D}{100} \times$ N metres per minute
    b. $\frac{\pi D}{N}$ metres per minute
    c. $\frac{D}{N} \times 100$ metres per minute
    d. $\frac{\pi N}{D}$ metres per minute

17. In the process chart, the 5 symbols ◯; □ ; ▽ ; ⇨ and D represent
    a. Inspection, Operation, transport, storage and delay respectively
    b. Operation, Inspection, storage, transport, and delay respectively
    c. Inspection, Operation, transport, storage and delay respectively
    d. Transport, Inspection, Operation, storage and delay respectively

18. When bevel gears having equal number of teeth and equal pitch angles connect two shafts whose axes intersect at right angle, they are known as:
    a. Angular bevel gears
    b. Internal bevel gears
    c. Mitre gears
    d. Crown bevel gears

19. The unit of measurement of coefficient of dynamic viscosity is:
    a. Newtons per second per square metre
    b. Newtons per square seconds per metre
    c. Newtons per square seconds per square metre,
    d. Newton seconds per square metre

20. In the pipe shown below, if a fluid of ρ=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 m/s
    b. 2 m/s
    c. 3 m/s
    d. 4 m/s

21. Which of the following is the high head hydraulic turbine?
    a. Pelton wheel
    b. Francis turbine
    c. Kaplan turbine
    d. Bulb turbine

22. Operation of coal fired power plants cause acid rain due to emission of:
    a. Carbon dioxide
    b. Suspended particulate matters
    c. Oxides of sulphur and nitrogen
    d. Volatile organic compound.

23. Diesel engines are often classed as compression-ignition engine because:
    a. Fuel is compressed before combustion
    b. Fuel is ignited by the heat of compression
    c. Compression of air-fuel mixture initiates ignition.
    d. Air is compressed

24. _____ is a locking device extensively used in automobile industry.
    a. Ring nut
    b. Jam nut
    c. Castle nut
    d. Screw nut

25. The groove angle of the pulley for V-belt is usually:
    a. $12^o – 18^o$
    b. $22^o – 28^o$
    c. $32^o – 38^o$
    d. $42^o – 48^o$

26. Why do two stroke petrol engines cause more environmental pollution than four stroke engines?
    a. Because less number of stroke leads to incomplete combustion
    b. Due to combustion of lubricating oil and exhaust of un-burnt fuel
    c. Because two stroke engines do not use valves
    d. Because spark plug is used for ignition

27. Following characteristic of fluidised bed combustion technology of coal leads to reduction in emission:
    a. Improved combustion
    b. Less consumption of fuel
    c. Nitrogen oxide formation is lower than traditional pulverized coal unit
    d. Flue gas scrubber unit is installed

28. The type of compressors most commonly used for pneumatic control applications is:
    a. Turbo compressors
    b. Positive displacement compressors
    c. Negative displacement compressors
    d. Centrifugal compressors

29. In electrochemical machining:
    a. The tool is made cathode and the work piece anode
    b. The tool is made anode and the work piece cathode
    c. The electrolyte functions as cathode and work piece as anode
    d. The electrolyte functions as anode and work piece as cathode

30. In spur gears, Diametral pitch × Circular pitch = _____.
    a. 1
    b. π
    c. $\frac{1}{\pi}$
    d. Number of teeth × π

PART – II : Short Answer Questions (20 marks)

Answer ALL the questions. Each question carries 5 marks.

1. 2.5kW power is transmitted by an open belt drive. The linear velocity of the belt is 2.5m/s. The angle of lap on the smaller pulley is 165^{o} and coefficient of friction is 0.3. determine the effect on power transmission if the initial tension in the belt is increased by 8%.

2. Differentiate between "hard" and "soft" automation. What is an "end effector" of a robot? List any 4 devices that equip the robot's wrist.

3. Determine the maximum, minimum and average pressure in a plate clutch when the axial force is 5kN and the inner and outer radius of the contact surface are 50mm and 100mm respectively. Assume uniform wear and ensure that the solution is in SI unit.

4. What are the causes of equipment breakdown? What are the different types of equipment maintenance? Give two advantages of each type of maintenance.

SECTION B
Case Study

Choose either Case 1 or Case 2 from this Section. Each Case carries 50 marks.

CASE 1

The Global Summit on the Future of Mechanical Engineering organized by the American Society of Mechanical Engineers (ASME) in 2008 came up with a vision statement called "2028 Vision for Mechanical Engineering" which stated that "Mechanical engineering will develop engineering solutions that foster a cleaner, healthier, safer and sustainable world".
The national strategic resource of Bhutan is the hydropower with a total estimated potential of about 30GW. Therefore, harnessing the hydropower resource is vital for the socio-economic development of the Country to achieve Gross National Happiness.

In line with the above vision, how do you plan to apply your mechanical engineering skills for the successful hydropower development in the country?

CASE 2

Mechanical engineers are indispensable for the design, production, and maintenance of medical equipment, tools and life support facilities. Knowledge of mechanical engineers on heating, ventilation and air conditioning, fluid mechanics/dynamics, thermodynamics, numerical methods, etc are valuable for the operation, maintenance and research initiatives in major hospitals. In the Bhutanese context, skills and knowledge of mechanical engineers could be gainfully utilized for the maintenance of medical equipment used by doctors for the diagnosis, monitoring or treatment of diseases to enhance the availability and reduce breakdowns of these vital equipment. As a result, the reliability of medical equipment will be greatly improved and medical services for the public will be enhanced. In doing so, Reliability Centred Maintenance (RCM) method can be appropriately adopted for planning of medical equipment maintenance programme in the hospital.

If you are appointed as a biomedical engineer at the Jigme Dorji Wangchuck National Referral Hospital (JDWNRH), Thimphu, how would you implement Reliability Centred Maintenance (RCM) programme for the maintenance of medical equipment. Present your proposal with clear description of the concepts and stages of RCM.