ROYAL CIVIL SERVICE COMMISSION
BHUTAN CIVIL SERVICE EXAMINATION (BCSE) 2015
EXAMINATION CATEGORY: TECHNICAL

PAPER III: SUBJECT SPECIALIZATION PAPER for *Mechanical Engineering*

Date	: 11 October 2015
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. In concurrent engineering approach:
   A. Most changes take place at every stage of product development
   B. Most changes take place at the initial stage of product development
   C. Most changes take place at the final stage of product development
   D. No changes take place in the product development process

2. What type of load is imposed upon the work material during a punching operation?
   A. Shear load
   B. Tensile load
   C. Compressive load
   D. Fluctuating load

3. Sorting of manufactured components into different groups as per their sizes, and then assembling the components of one group to corresponding components of a matching group is called:
   A. Matched assembly
   B. Sorted assembly
   C. Selective assembly
   D. Preferred assembly

4. When the center of gravity of a rotating body coincides with the axis upon which it revolves, the body is said to be in:
   A. Standing balance
   B. Dynamic balance
   C. Circular balance
   D. Revolving balance

5. The welder holds welding torch in the right hand and filler rod in the left hand in:
   A. Leftward welding technique
   B. Rightward welding technique
   C. Forehand welding method
   D. In all above techniques.

6. In ....., the rate of deformation is directly proportional to the applied shear stress:
   A. Newtonian Fluid
   B. Non-Newtonian Fluid

C. Ideal Fluid
D. Static Fluid

7. A gear used between a driver and follower gear to maintain the direction of rotation is called:
   A. Ring gear
   B. Idler
   C. Pinion
   D. Sun gear

8. Scotch Yoke Mechanism converts:
   A. One rotary motion to another rotary motion
   B. Linear motion into rotary motion
   C. Rotary motion into linear motion
   D. Sliding motion into rotary motion

9. The use of stethoscope for inspection and testing of weld welds works on the principle:
   A. Defective weld metals give good ringing note while striking
   B. Defect-free meld metals give flat note while striking
   C. Defect-free weld metals give good ringing note while striking
   D. Defective weld metals give flat not while striking

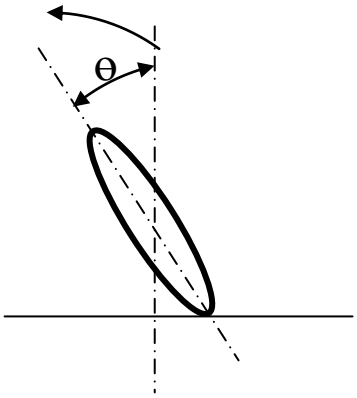
10. Which of the following statement is true regarding sheet metal blanking and punching:
    A. Material cut from stock is the scrap in both blanking and punching.
    B. Material cut from stock is the work piece in both blanking and punching.
    C. Material cut from stock is the scrap in blanking while it is the work piece in case of punching
    D. Material cut from stock is the work piece in blanking while it is the scrap in case of punching

11. If diameters of driving and driven pulley of a belt drive are 500mm and 250mm respectively, the velocity ratio is:
    A. 2
    B. 2π
    C. 1
    D. $\frac{1}{2}$

12. Acceleration of a moving body acts:
    A. Opposite to the direction of the change in velocity
    B. In the direction of the change in velocity
    C. Perpendicular to the direction of change in velocity
    D. Independent of the change in velocity

13. In plant and equipment maintenance, MTBF stands for:
    A. Mean Time Between Failures
    B. Minimum Time Between Failures
    C. Minimum Time Before Failures
    D. Mean Time Before Failures

14. In the adjacent diagram showing one of the wheels of a scooter taking a left turn for equilibrium, "**θ**" is known as:



    A. Steering angle
    B. Gyroscopic angle
    C. Angle of turn
    D. Angle of heel

15. In automobile, total gyroscopic couple is positive:
    A. When engine parts and wheels rotate in opposite direction
    B. When engine parts and wheels rotate in the same direction
    C. When engine parts and wheels rotate in directions perpendicular to each other
    D. When the automobile comes to rest.

16. If *"N"* is the number of instantaneous centres and *"n"* is the number of bodies or links:
    A. $N = \frac{n(n-1)}{2}$
    B. $N = \frac{n(n+1)}{2}$
    C. $N = \frac{n(n-1)}{2n}$
    D. $N = \frac{n+1}{2n}$

17. The Thermblig symbol for "Grasp" is:
    A. #
    B. ∪
    C. ∩
    D. ⫲

18. If the stress in the round mild steel rod supporting a tensile load of 50kN is limited to 100N/mm^2, the diameter (d) of the rod is:
    A. 25.23mm
    B. 23.25mm
    C. 22.53mm
    D. 20mm

19. For brittle materials, factor of safety is given by:
    A. $\frac{\text{Maximum Stress}}{\text{Working or design stress}}$
    B. $\frac{\text{Yield point stress}}{\text{Working or design stress}}$
    C. $\frac{\text{Ultimate Stress}}{\text{Working or design stress}}$
    D. $\frac{\text{Buckling Stress}}{\text{Working or design stress}}$

20. Keyway cut into the shaft
    A. Improves the load carrying capacity of the shaft
    B. Reduces the load carrying capacity of the shaft
    C. Doubles the load carrying capacity of the shaft
    D. Does not affect the load carrying capacity of the shaft

21. The branch of engineering concerned with the designs, improvement and installation of integrated systems of people, materials, equipment and energy is called:
    A. Concurrent engineering
    B. Production engineering
    C. Team engineering
    D. Industrial Engineering

22. A screw is said to be self locking if its efficiency is:
    A. Less than 25%
    B. Less than 50%
    C. Less than 75%
    D. Less than 5%

23. The flywheel arms will be subjected to _____ due to the centrifugal force acting on it.
    A. Shear stress
    B. Compressive stress
    C. Tensile stress
    D. Hoop stress

24. A leaf spring in automobiles is used.
    A. To apply forces
    B. To measure forces
    C. To absorb shocks
    D. To store energy

25. The backlash for spur gears depends upon:
    A. Module
    B. Tooth profile

C. Pressure angle
D. Tooth thickness

26. The angle of contact of the bearing with the journal in a full journal bearing is:
    A. 120^o
    B. 180^o
    C. 270^o
    D. 360^o

27. Four stroke engine requires:
    A. One crankshaft revolution per cycle
    B. Two crankshaft revolutions per cycle
    C. Three crankshaft revolutions per cycle
    D. Four crankshaft revolutions per cycle

28. In metal cutting, machinability is expressed in terms of:
    A. Chip thickness ratio
    B. Change in cutting speed
    C. Frequency of tool breakage
    D. Work completion rate

29. Oldham's coupling is used to connect two parallel shafts:
    A. When the distance between their axes is small
    B. When the distance between their axes is large
    C. When the shafts are of equal size
    D. When the shafts are of different size

30. A shaft revolving at a speed of 120rpm has an angular velocity of:
    A. 12.57 m/s
    B. 12.57 rpm
    C. 12.57 rad/s
    D. 12.57 degrees

PART II – Short Answer Type Questions (20 Marks)

Answer ALL the questions. Each question carries 5 marks. Mark for each sub-question is indicated in the brackets.

1. A desk fan having diameter of 30cm rotates at 200rpm. Air enters the fan at 3m/s parallel to the axis of rotation. **(5 Marks)**

a. Draw a labeled sketch of the velocity triangle for the fan showing the air velocity (V_a), frame velocity of the fan (V_f) and relative velocity (V_r). **(2 Marks)**

b. Compute the relative velocity at the tip of the fan. **(3 Marks)**

2. a. Explain the function of coupling **(2 Marks)**
   b. Give at least three requirements of shaft coupling. **(3 Marks)**

3. Briefly explain four-stroke cycle of a petrol engine. **(5 Marks)**

4. A shaft runs at 80 rpm and drives another shaft at 150 rpm through belt drive. The diameter of the of the driving pulley is 600mm. Determine the diameter of the driven pulley in the following cases **(5 Marks)**
   i. Neglecting belt thickness. **(1 Mark)**
   ii. Taking belt thickness as 5mm. **(1 Mark)**
   iii. Assuming a total slip of 4% for ii above. **(1 Mark)**
   iv. Assuming a slip of 2% on each pulley for ii above. **(2 Marks)**

SECTION B

Case Study

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

1. The phrase, "The early bird catches the worm" holds true in engineering in the modern industrialized and competitive world. Companies which are able to introduce new products and their updates early into the market thrive well. Concurrent Engineering is one of the tools that enable companies to achieve such advantages if implemented and managed rightly and timely.

   Consider that you are a new engineer recruit in a manufacturing company. The Chief Executive Officer (CEO) of the company asks you to review the company's product development strategy and submit a proposal to fast track the introduction of product into the market. In this regard, develop a concept proposal on adoption of concurrent engineering to be submitted to the CEO. Ensure that your proposal captures the following, amongst others:
   - Background concept on concurrent engineering.
   - Comparison between traditional product development method and concurrent engineering
   - Elements/Components of concurrent engineering
   - Resources required
   - Challenges

- Relevant Sketches/flow charts

OR

2. Municipal Solid Waste (MSW) management is one of the growing concerns in Bhutan. If properly planned and implemented, there is possibility of turning wastes to resources. Therefore, waste management is pursued as viable business establishment in developed countries.

   As a concerned citizen of the country and a mechanical engineer, provide your proposal to tackle the waste management problem in Bhutan.

   Your proposal should include the following besides others.

   - Definition and background of waste management
   - Problems concerning wastes; domestic as well as international
   - National legal and policy frameworks including Acts, Regulations, Policies and Strategies concerning waste management and that support waste management facilities start ups in Bhutan
   - Any international legal framework concerning waste management
   - Different solid waste management methods and their advantages and disadvantages
   - General principles of waste management including waste management hierarchy
   - Issues pertaining to solid waste management
   - Resources required
   - Benefits
   - Challenges