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

## PAPER III: SUBJECT SPECIALIZATION PAPER for *ELECTRICAL ENGG. / ELECTRICAL & ELECTRONICS ENGG.*

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| **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 **11** printed pages in all, including this instruction page.

**GOOD LUCK!**

# SECTION A

## PART I - Multiple Choice Questions (30 Marks)

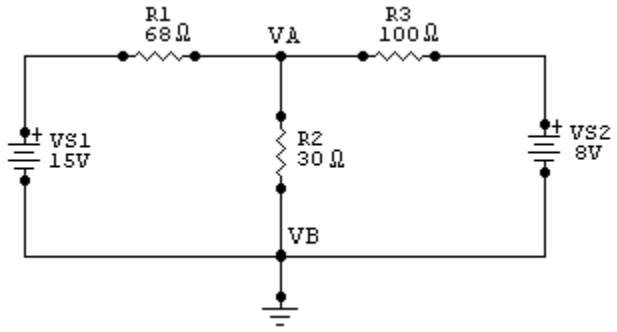
**Choose the correct answer and write down the letter of the correct answer chosen in the Answer Booklet against the question number. E.g. 31 (c). Each question carries ONE mark. Any double writing, smudgy answers or writing more than one choice shall not be evaluated.**

1. The open circuit test is carried out in a transformer to find the
   a) Cu loss
   b) Core loss
   c) Total loss
   d) Insulation resistance

2. You are measuring the current in a circuit that is operated on an 18 V battery. The ammeter reads 40 mA. Later you notice the current has dropped to 20 mA. How much has the voltage changed?
   a) 9V
   b) 900mV
   c) 0V
   d) 18V

3. A 120 V lamp-dimming circuit is controlled by a rheostat and protected from excessive current by a 3 A fuse. To what minimum resistance value can the rheostat be set without blowing the fuse? Assume a lamp resistance of 20 ohms.
   a) 40 Ω
   b) 4 Ω
   c) 2 Ω
   d) 20 Ω

4. Find the node voltage VA.




   a) 518 mV
   b) 5.18 V

c) 9.56 V
d) 956 mV

5. The branch current method uses
   a) Kirchhoff's voltage and current laws
   b) Thevenin's theorem and Ohm's law
   c) Kirchhoff's current law and Ohm's law
   d) the superposition theorem and Thevenin's theorem

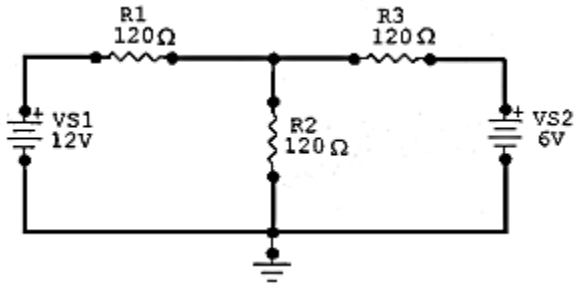
6. In a certain three-wire Y-connected generator, the phase voltages are 2 kV. The magnitudes of the line voltages are
   a) 2000V
   b) 6000V
   c) 666V
   d) 3464

7. A three-phase generator is connected to three 90 Ω load resistors. Each coil generates 120 V ac. A common neutral line exists. How much current flows through the common neutral line?
   a) 0V
   b) 1.33 V
   c) 3.99 V
   d) 2.66 V

8. When the current is 2.5 A, how many coulombs pass a point in 0.2 s?
   a) 12.5 C
   b) 1.25 C
   c) 0.5 C
   d) 5C

9. A 6 V battery is connected to a 300 Ω load. Under these conditions, it is rated at 40 Ah. How long can it supply current to the load?
   a) 1 h
   b) 200 h
   c) 2,000 h
   d) 10 h

10. Find the current in R2 of the given circuit, using the superposition theorem.




a) 16.7 mA
b) 33.3 mA
c) 50 mA
d) 16.6 mA

11. If the cross-sectional area of a magnetic field increases, but the flux remains the same, the flux density
    a) Increases
    b) Decreases
    c) Remains the same
    d) Doubles

12. A 12 kΩ resistor is in series with a 90 mH coil across an 8 kHz ac source. Current flow in the circuit, expressed in polar form, is I = 0.3∠0° mA. The source voltage, expressed in polar form, is
    a) 3.84∠20.6° V
    b) 12.8∠20.6° V
    c) 0.3∠20.6° V
    d) 13.84∠69.4° V

13. If a load is purely inductive and the reactive power is 12 VAR, the apparent power is
    a) 0VA
    b) 12 VA
    c) 6 VA
    d) 24 VA

14. Which of the following does not change in a transformer?
    a) Current
    b) Voltage
    c) Frequency
    d) All the above

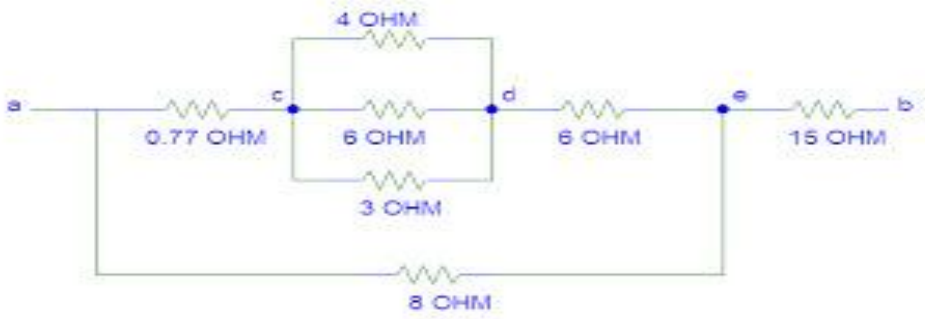
15. The three terminals of IGBT are
    a) Collector, emitter, base
    b) Drain, source, base
    c) Drain, source, gate
    d) Collector, emitter, gate

16. Silicon steel used in laminations mainly reduces
    a) Hysteresis loss
    b) Eddy current losses
    c) Copper loss
    d) All the above

17. In N-type semiconductor, the minority carriers are
    a) Electrons
    b) Protons
    c) Holes
    d) Positrons

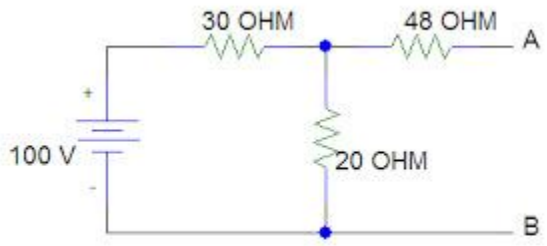
18. If the resistance of a material at 0 ℃ is 3.83 Ω and its temperature co-efficient,$\propto$ =2.27 $\times 10^{-3}$, What is the resistance at 60 ℃?
    a) 4.15 Ω
    b) 4.35 Ω
    c) 4.45 Ω
    d) 4.20 Ω

19. Find Rab




    a) 20 Ω
    b) 18 Ω
    c) 19 Ω
    d) 17 Ω

20. Find Rth




a) 55 Ω
b) 50 Ω
c) 65 Ω
d) 60 Ω

21. Advantage of transmitting power at high voltage is
a) magnitude of current will be high
b) power loss will be less
c) it will reduce the voltage drop in the line impedance
d) all the above

22. The earth's potential is taken as
a) infinite
b) supply voltage
c) 1 volt
d) zero

23. The lightning arrestor is connected
a) in series with the line
b) between line and the earth
c) to a pole near the line
d) to the circuit breaker

24. The advantage of hydropower plants is
a) low operating costs
b) the can be started and loaded easily
c) they can be used as base load plants as well as peak load plants
d) all the above

25. The voltage and frequency of infinite bus bar
    a) increases
    b) decreases
    c) remains constant
    d) voltage increases and frequency decreases

26. What is full form of ABC cable?
    a) Aluminum Bunched Cable
    b) Ariel Bundled Cable
    c) All buried cable
    d) Aluminum Bronze Cable

27. Fuse is inserted in
    a) neutral wire
    b) earth wire
    c) live wire
    d) any of the above

28. Which one is not true about earthing?
    a) saves human from leakage current
    b) protect from atmospheric lightening
    c) maintains constant line voltage
    d) replaces fuse

29. To convert DC to AC, we use
    a) Thyristor
    b) Rectifier
    c) Alternator
    d) Inverter

30. Resistance of a wire depends on
    a) Cross-sectional area of the wire
    b) Material of the wire
    c) Temperature of the wire
    d) All the above

## PART – II : Short Answer Questions (20 marks)

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

**1) a)** Given the two binary numbers X = 1010100 and Y = 1000011, perform the subtraction

**i)** X-Y (1 Mark)

**ii)** Y-X using 2's complement. (1 Mark)

**b)** Simplify the following expression Y = (A+B)(A+C')(B'+C') (3 Marks)

**2)** The armature resistance of a permanent magnet dc motor is 0.8 Ω. At no load, the motor draws 1.5 A from a supply voltage of 25 V and runs at 1500 rpm. What is the efficiency of the motor while it is operating on load at 1500 rpm drawing a current of 3.5 A from the same source? (5 Marks)

**3)** A 800 kV transmission line is having per phase line inductance of 1.1 mH/km and per phase line capacitance of 11.68 nF/km. Ignoring the length of the line, what will be its ideal power transfer capability in MW? What is the effect of high capacitance on the transmission line? (5 Marks)

**4)** A capacitor consists of two metal plates each 500 x 500 $mm^2$ and spaced 6 mm apart. The space between the metal plates is filled with a glass plate of 4 mm thickness and a layer of paper of 2 mm thickness. The relative permittivity of the glass and paper are 8 and 2 respectively. Neglecting the fringing effect, what is the capacitance? (Given that $\varepsilon_0 = 8.85 \times 10^{-12}$ F/m ) (5 Marks)

# SECTION B
## Case Study

**Choose either Case 1 or Case 2 from this Section. Each Case carries 50 marks. Mark for each sub-question is indicated in the brackets.**

## CASE 1

The Royal Government of Bhutan is planning to electrify Lingzhi village. Your service is hired to design a micro hydropower with following data made available to you by the government.

Head : 40m
Discharge: 0.52 cumecs
Efficiency of electro-mechanical machines in powerhouse: 70%
No. of households : 80
*Assume no other losses.*

**A.** Sketch and label a micro hydropower plant including basic components. (5 Marks)

**B.** Calculate the installed plant capacity. (2 Marks)

**C.** If the load demand per household is 1.5kW throughout the year calculate the plant factor. (2 Marks)

**D.** The capital cost of the micro hydro power plant is Nu. 10 million. Assuming plant factor as **0.8** and no operating cost, calculate unit cost of energy. (2 Marks)

**E.** Which type of turbine will you use? (1 Mark)

**F.** Which type of ac generator will you use, synchronous generator or induction generator? Why? (3 Marks)

**G.** Calculate the rpm of a synchronous generator which has 4 poles. (2 Marks)

**H.** Why is ac generator preferred over dc generator? (3 Marks)

**I.** What is the difference between self excited generator and separately excited generator? (2 Marks)

**J.** What is AVR? What is its function? (3 Marks)

**K.** What is Electronic Load Controller governor? How does water cooled ballast function? (3 Marks)

**L.** Given the difficulty in transportation to Lingshi, which of the following option would you prefer: ( give a reason) (2 Marks)

- **a.** two units with half capacity
- **b.** one unit of full capacity

**M.** Does the energy generation meet the demand of the village if the load per house is 2 kW? Provide solutions for additional power. (3 Marks)

**N.** In what condition would you use gear box or belt between turbine and generator? Which one is better, belt or gear box and why? (3 Marks)

**O.** Describe conversion of energy type from water source till electricity generation. (2 Marks)

**P.** What is the minimum power factor normally used? (1 Marks)

**Q.** Name two causes of over-current. What can we use to protect system against over-current. (3 Marks)

**R.** Give two advantages of 3 phase over single phase ac systems. Give one advantages of single phase ac systems. (3 Mark)

**S.** If the speed of the turbine and generator available does not match, what would you do? (1 Mark)

**T.** What is the limitations and advantage of belt drives? (2 Mark)

**U.** Name two existing micro hydropower plants in Bhutan. (2 Marks)

## CASE 2

Your house requires 4 fluorescent lights, 4 fans, one refrigerator and one air conditioner and is supplied from single phase 230 volt line. Answer the following questions related to electrical fittings and wiring in the house:

**A.** Considering 40W fluorescent lights, 60W fans and a 5/6pin 16A socket outlet, calculate the total connected load in Watts and the demand loads as practiced in the country. (5 Marks)

**B.** Calculate the full load current in above question. (2 Marks)

**C.** List six important electrical components required in a building. (4 Marks)

**D.** What is earthing? Why is it important to have earthing for buildings? (4 Marks)

**E.** What are the factors affecting earth resistance? Explain how each factor affects the earth resistance. (5 Marks)

**F.** What are the methods of testing the wiring installations? (2 Marks)

**G.** When is radial main system of wiring used? What is its disadvantage over ring main system of wiring? (5 Marks)

**H.** Lightning arrestor is one of the electrical fitting used in the buildings to protect against lightning. State briefly how it protects the building and the structures? (3 Marks)

**I.** Independent lighting circuits are advisable for lamps and motor. Explain. (3 Marks)

**J.** What is 'diversity factor'? Why is it used in the assessment of maximum demand? (2 Marks)

**K.** Why is the location of the MCB or MCCB always in dry and well ventilated places? (2 Marks)

**L.** What kind of electrical protection devices are required? List 3 of them. (3 Marks)

**M.** A lamp of 500 cp is suspended 4 m above the horizontal surface. Calculate the illumination: i. directly below the lamp ii. 3m away from the vertical axis. (5 Marks)

**N.** Name three types of lamps used for lighting in Bhutan. What is the commonly used lamp along the Thimphu express way? (3 Marks)

**O.** What is the purpose of chokes in fluorescent tubes? (2 Marks)