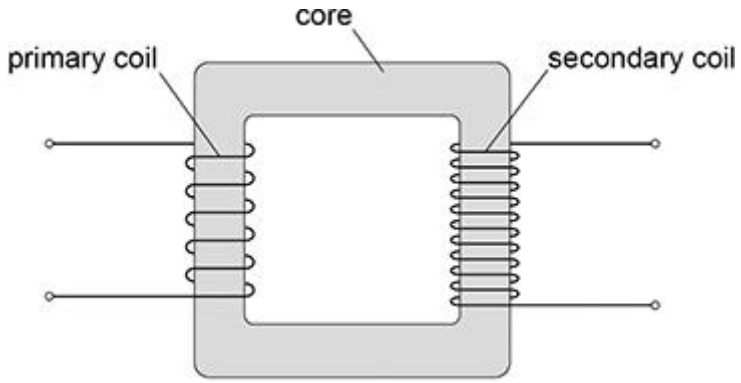
Name of the Student:_____
Max. Marks : 21 Marks **Time : 21 Minutes**

Q1.

Figure 1 shows a transformer.

Figure 1



(a) Explain the functions of the core and the secondary coil.

core _____

_____

_____

_____

secondary coil _____

_____

_____

_____

_____

_____

(3)

(b) **Figure 2** shows a cross-section through the transformer core. Thin iron sheets are separated by material **M**.

Explain how the efficiency of the transformer is increased by constructing the core in this way.

Figure 2

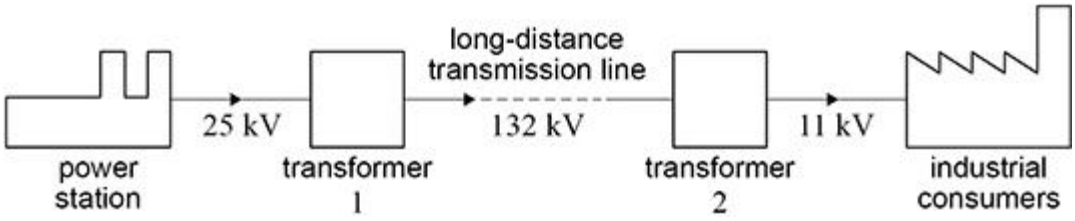
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(3)

Figure 3 shows a schematic diagram of a power transmission system.

Figure 3



(c) Voltages between $33\ \text{kV}$ and $400\ \text{kV}$ are used for long-distance transmission.

Suggest why engineers have chosen $132\ \text{kV}$ for this system.

(2)

(d) The industrial consumers use $72\ \text{MW}$ of power.
Transformers 1 and 2 each have an efficiency of 98% and the transmission line has an efficiency of 94%.

Calculate the current in the $25\ \text{kV}$ line from the power station.

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current = _____ A

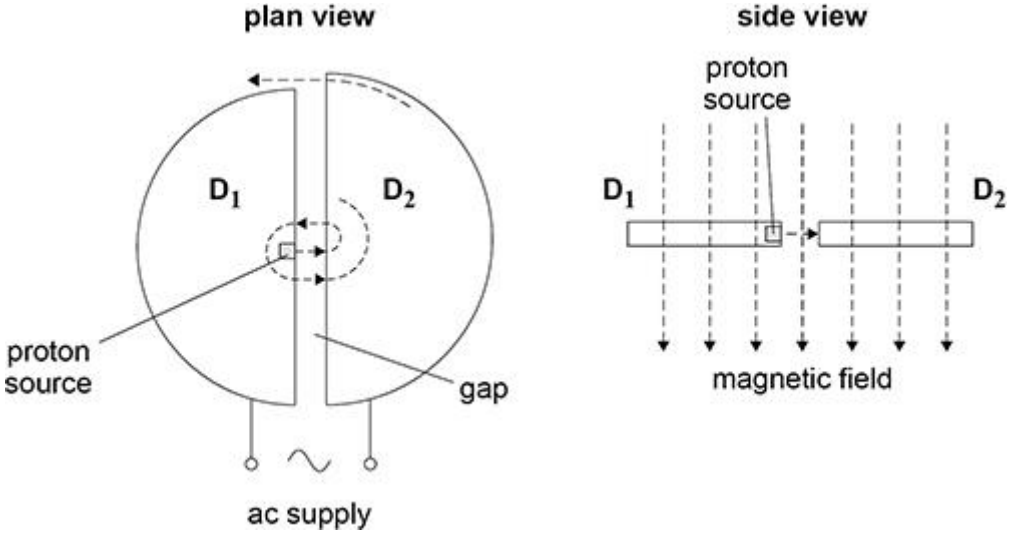
(3)

(Total 11 marks)

Q2.

The figure below shows a cyclotron. A proton is released from rest and is accelerated each time it reaches the gap between two horizontal 'dees' **D_1** and **D_2**. Between these accelerations the proton moves at constant speed. A vertical magnetic field of flux density B acts over the dees so that the proton follows a semicircular path in each dee.

The dees are connected to an alternating potential difference (pd).
This pd is adjusted so that the proton is always accelerated by the peak electric field as it crosses the gap between the dees.



(a) Explain why the proton travels in a semicircular path in a dee.

_____

_____

_____

_____

_____

_____

(2)

(b) The peak pd of the alternating supply is 10.0 kV. The proton leaves the cyclotron with kinetic energy of 14 MeV.

Determine the number of times the proton moves across the gap before it leaves the cyclotron.

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number of times = _____

(1)

The radius of the outermost semicircular path of the proton is R and the proton leaves with a maximum kinetic energy E_k.

(c) Show that E_k is given by

$$E_k = \frac{e^2 B^2 R^2}{2m_p}$$

(3)

(d) A hospital decides to purchase a cyclotron in order to manufacture its own radioactive isotopes using high-speed protons.
The required minimum kinetic energy of the emerging protons is 11 MeV.
The cost of a cyclotron is approximately proportional to $E_k^{1.5}$.
The cost of a 10 MeV cyclotron is about £2.3 million.
The table below gives information for three cyclotrons **X**, **Y** and **Z**.

Cyclotron	***B* / T**	***R* / m**
X	1.3	0.38
Y	1.1	0.50
Z	0.5	0.60

Deduce which cyclotron **X**, **Y** or **Z** will satisfy the energy requirement for the lowest cost.
Go on to determine the approximate cost of this cyclotron.

cyclotron = _____

cost = _____

(4)

(Total 10 marks)

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