

2020

PHYSICS — HONOURS

Paper : SEC-A-2

(Renewable Energy and Energy Harvesting)

For Syllabus 2019-2020

Full Marks : 80

The figures in the margin indicate full marks.

*Candidates are required to give their answers in their own words
as far as practicable.*

1. Answer **any ten** questions from question 1 : 2×10
- (a) What do you mean by greenhouse effect?
 - (b) What is solar cell? Write down its one important use of it.
 - (c) Name two major fossil fuels used by us.
 - (d) List two differences between tidal and wave energy.
 - (e) Define the conversion efficiency of a fuel cell.
 - (f) Explain why the wind energy is a renewable source.
 - (g) What are the advantages of geothermal energy over other forms of energy?
 - (h) Define Piezoelectric effect. Name one Piezoelectric substance.
 - (i) What is biomass?
 - (j) Mention the factors on which the generation of hydroelectricity depend.
 - (k) What do you understand by Carbon capture technology?
 - (l) Explain the term isobar. Give one example of it.
2. Answer **any four** questions.
- (a) (i) Write two advantages and disadvantages of biomass energy.
 - (ii) What is solar photovoltaic system? What are its major advantages over conventional power systems? 2+(1+2)
 - (b) Compare among thermal energy, hydroenergy and nuclear energy. 5
 - (c) Explain how energy is released in nuclear fission process of ${}_{92}\text{U}^{235}$. Is nuclear energy renewable or not? 4+1
 - (d) What is a linear generator? Explain its working principle. 1+4

Please Turn Over

- (e) Explain with a neat diagram, how wind energy can be converted into electrical energy. 5
- (f) (i) What is the amount of solar energy incident per square meter of the earth's surface in Watt?
(ii) Explain briefly the working principle of a solar cooker. Mention one of its disadvantage. 1+(3+1)

3. Answer **any four** questions.

- (a) (i) What is the full form of OTEC? What is its basic principle?
(ii) Explain with a diagram the method of tidal power generation. What are its limitations? (1+3)+(4+2)
- (b) (i) What are the advantages of conventional sources of energy?
(ii) What are flat plate solar collectors? What are the advantages and disadvantages of flat plate solar collectors? Why copper is chosen as the absorber plate material?
(iii) What is the basic principle of operation of a solar pond? 3+(1+2+2)+2
- (c) (i) Mention the main factors to be considered for proposing a wind power site.
(ii) Derive an expression for energy available in the wind.
(iii) Draw a neat diagram of the basic components of a wind electric system and briefly explain it. 4+3+3
- (d) (i) Briefly discuss about any two methods of piezoelectric energy harvesting.
(ii) Describe the piezoelectricity mathematically explaining the terms. 4+6
- (e) Write a note on energy conservation, energy strategy and sustainability and its importance in present day scenario. 3+3+2+2
- (f) Write short notes on **any two** of the following :
(i) Ocean biomass
(ii) Global warming
(iii) Osmotic power. 5+5
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Syllabus – 2018-2019
(Electrical Circuits and Network Skills)

Full Marks : 80

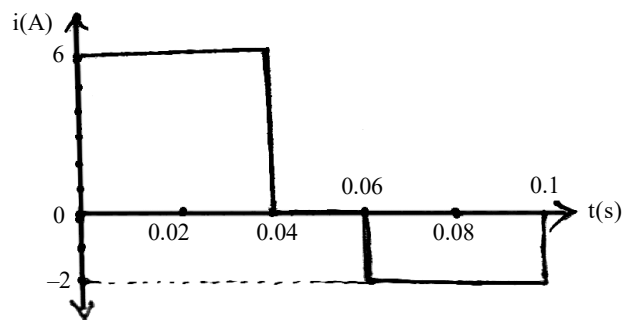
1. Answer *any five* questions :

2×5

(a) An ideal current source has

- (i) infinite internal resistance
- (ii) zero internal resistance
- (iii) large value of voltage
- (iv) none of the above.

(b) A varying current with a waveform as shown below is flowing through an 8Ω resistor.



Here the r.m.s value of the current is

- (i) 2A
- (ii) 3.5A
- (iii) 4A
- (iv) none of these.

(c) Which of the following factors determine the design of the transmission power lines?

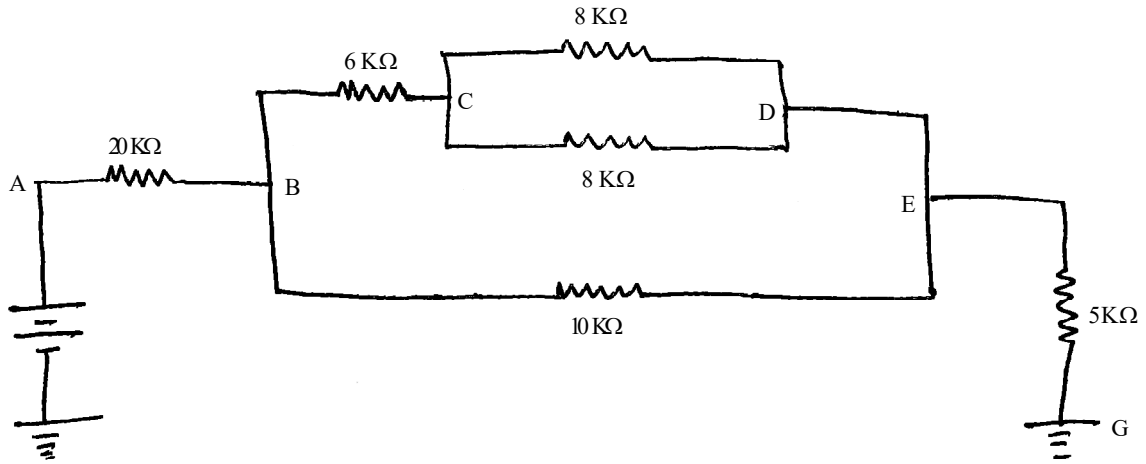
- (i) cost of the power line
- (ii) amount of power to be transmitted
- (iii) distance over which power is to be transmitted
- (iv) all of the above.

(d) The air gap between the rotor and stator of an induction motor is kept very small so as to obtain

- (i) minimum air friction
- (ii) minimum field strength
- (iii) maximum field strength
- (iv) maximum reluctance.

Please Turn Over

(e) Compute the resistance of the entire circuit between A and G

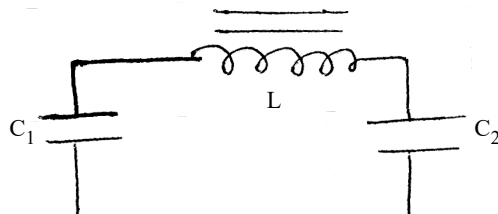


- (i) 20 kΩ (ii) 25 kΩ (iii) 30 kΩ (iv) 57 kΩ.

(f) When a PN junction is forward biased, current flows due to

- (i) minority carrier injection (ii) majority carrier injection
 (iii) establishment of barrier potential (iv) Avalanche action.

(g)



The above figure belongs to

- (i) C filter (ii) L filter (iii) LC filter (iv) Pi filter.

2. Answer **any five** questions :

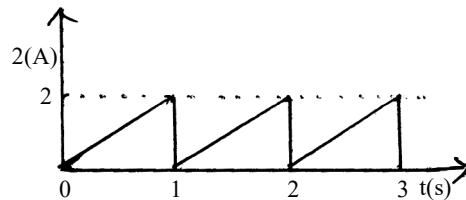
- (a) What is the role of fuse in an electric circuit? What material is used for making fuse wire? 1+1
- (b) What is the unit of admittance? Find the admittance of the circuit having the impedance $(6+j8)\Omega$. 1+1
- (c) Why is the 3-phase induction motor most commonly used AC motor in industry? 2
- (d) Write the difference between Ideal voltage source and practical voltage source. Draw their V-I characteristics. 2
- (e) What do you mean by dielectric loss and power factor of a capacitor? 2

- (f) In a parallel RLC circuit where R, L, C all are connected in parallel with an ac supply, if the currents flowing through R, L and C are respectively 3mA, 5mA and 1mA, then what will be the total supply current? 2
- (g) What are the differences between relay and circuit breaker? 2

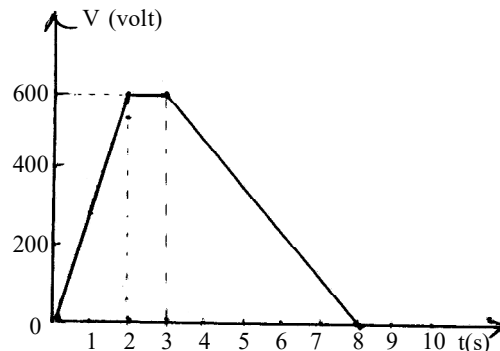
Group – A

3. Answer *any four* questions.

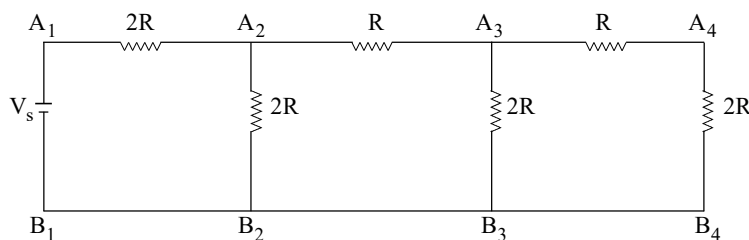
- (a) (i) What is a circuit breaker? What are the common types of circuit breakers that are used in electrical networks?
- (ii) For the sawtooth waveform shown here, find the average and r.m.s. values of the current. (1+2)+2



- (b) The voltage applied across a 10 μF capacitor is varied as shown in the figure below.

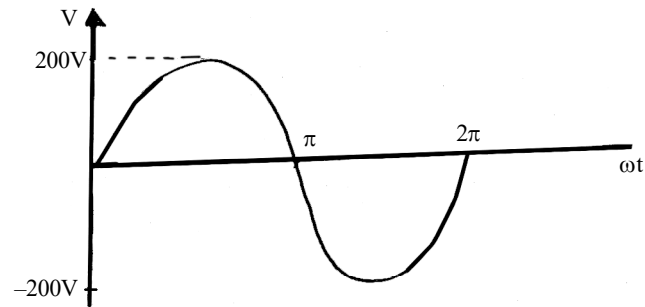


- (i) Plot the variation of current during this 8 seconds.
- (ii) Calculate the charge and energy stored in the capacitor when the voltage is 600V. 3+2
- (c) (i) What are the key differences between a single phase and three phase AC supply?
- (ii) A circuit having a 4Ω resistor, a 0.5H inductor and a variable capacitor in series is connected across 100V, 50Hz supply. Calculate the capacitance to give the resonance. 3+2
- (d) For the given ladder network find the current in the load resistance and the voltage across it.



$$V_s = 16\text{V}, \quad R = 1\text{K}\Omega.$$

- (e) A sinusoidal voltage $V(t) = 200 \sin 1000 t$ is applied across a pure capacitor of $100 \mu\text{F}$.



Find current $i(t)$, charge $q(t)$, power $p(t)$. Draw sketches of current and power. 3+2

- (f) With proper examples, make a comparison between Star and Delta Connections in electrical wiring. 5

Group – B

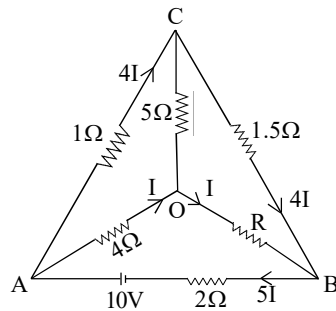
4. Answer *any four* questions.

- (a) (i) With neat sketches describe the basic construction and working of a AC generator.
 (ii) How can the output voltage of a DC generator be increased?
 (iii) Explain the terms ‘Hysteresis Loss’ and ‘Eddy Current Loss’ of a DC generator. How can they be minimised? (2+3)+1+(2+2)
- (b) (i) What is meant by ‘shunt’ and ‘multiplier’?
 (ii) Briefly describe how an ammeter of range $(0-I_m)\text{A}$ can be converted to a voltmeter of range $(0-V_m)\text{V}$.
 (iii) A moving-coil instrument of resistance 10Ω requires a potential difference of 150mV to give a full-scale deflection. Calculate the value of resistance that need to be used to enable the instrument to work as
 (i) an ammeter of range $(0-10)\text{A}$.
 (ii) a voltmeter of range $(0-150)\text{V}$. 2+3+(2½+2½)
- (c) (i) What are the two types of constructions generally used in transformers? Compare the two types of these transformers.
 (ii) What are the properties of an ideal transformer?
 (iii) What is the ‘Cu Loss’ that take place in a transformer? What are the factors that affects the ‘Cu Loss’?
 (iv) The number of turns on the primary and secondary windings of a single-phase transformer are respectively 200 and 20. If the primary is connected to a 1.2 KV, 50 Hz supply, what would be the secondary voltage? (1+3)+2+(1+1)+2

(7)

T(3rd Sm.)-Physics-H/SEC-A-2/CBCS

- (d) (i) A coil of resistance 7Ω and inductance 31.8 mH is connected to a 230V , 50Hz supply. Calculate, the circuit current and phase angle.
- (ii) Two impedances given by $Z_1 = (8 + j6)\Omega$ and $Z_2 = (10 + j5)\Omega$ are connected in parallel across a supply of $V = (200 + j0)\text{V}$. Calculate the branch currents and the power factor of the circuit. (3+2)+(3+2)
- (e) (i) 220V dc machine has an armature resistance of 0.5Ω . If the full load armature current is 20A , find the induced emf, when the machine acts as
(A) generator (B) motor.
- (ii) What is Armature Reaction? Explain it using a neat diagram.
- (iii) From the Voltage equation of a motor, find the expression for speed of a D.C. motor. (2+2)+(1+2)+3
- (f) In the circuit shown below, calculate the value of the unknown resistance R and the current flowing through it when the current in branch OC is zero.



5+5