ENGG1310 Electricity and Electronics

Past Paper Solutions

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Hint: To navigate the solutions more efficiently, you can refer to the By-year Index, which organises questions by their respective examination dates (latest first), or the By-topic Index, which categorises questions based on their topics. Both indices are located at the end of this document.

2024 Dec

Section A – Multiple-choice Questions

2024 Dec Q1

Electronics # Semiconductor

Solution: A

Holes are defined as the absence of electrons in the valence band, they cannot "move" to the conduction band. Therefore, D and E are incorrect. Electrons cannot exist in the band gap, so C is incorrect. Electrons have more energy in the conduction band than in the valence band, so A is correct.

2024 Dec Q2

Electronics # Semiconductor

Solution: C

In a p-type ("p" stands for "positive") semiconductor, the majority carriers are holes. Therefore, A and B are incorrect. Since holes are the majority carriers, there are more holes than electrons, so C is correct and D is incorrect.

2024 Dec Q3

Electronics # Diodes

Solution: C

In a reverse-biased diode, no current flows through, so A and B are incorrect. To put the diode in reverse bias, a higher potential must be applied to the n-type side, i.e., cathode, so C is correct and D is incorrect.

2024 Dec Q4

Electronics # Diodes

Solution: E

In a forward-biased diode, the mathematical relationship between input voltage and output current is exponential, so only E is correct. (Side note: in a reverse-biased diode, the relationship remains rather constant.)

2024 Dec Q5

Electronics # BJT

Solution: B

`NAND` gates (or any gates involving `NOT`) need to be constructed using active components, i.e., transistors, so only B is correct. The other options are all passive components.

2024 Dec Q6

Electronics # Semiconductor

Solution: C

Transconductance g_m measures how well the input voltage is converted to output current, so C is correct.

2024 Dec Q7

Electronics # Optoelectronics

Solution: C

Explanation:

(i) The colour of light in LEDs is determined by the band gap of the semiconductor. Correct.

(ii) An LED emits light when electrons are interjecting from the conduction band to the valence band, which only happens when forward-biased. Correct.

(iii) Light is emitted when electrons falls from the conduction band to the valence band (recombination with holes), releasing energy in the form of photons. Incorrect.

(iv) Same as (iii). Correct.

Therefore, (i), (ii), and (iv) are correct, so C is correct.

2024 May

Section A – Multiple-choice Questions

2024 May Q1

#Electronics #Semiconductor

Solution: D

Free electrons exist in the conduction band, so D is correct.

2024 May Q2

#Electronics #Semiconductor

Solution: A

In an n-type semiconductor, holes are the minority carriers. Also, minority carriers are always thermally generated, while majority carriers are always generated by doping, so A is correct.

2024 May Q3

#Electronics #Diodes

Solution: B

In a forward-biased diode, current is conducted. Therefore, B is correct.

2024 May Q5

#Electronics #MOSFET

Solution: E

The three terminals of a metal-oxide-semiconductor field-effect transistor (MOSFET) are called gate, drain, and source, so E is correct. “n, p, n” and “p, n, p” are the three layers of a bipolar junction transistor (BJT), so A and B are incorrect. “input, output, ground” are related to logic gates, not MOSFETs, so C is incorrect. “emitter, base, collector” are the three terminals of a BJT, so D is incorrect.

2024 May Q7

#Electronics #Electromagnetics

Solution: E

The electric field and the magnetic field are orthogonal (perpendicular) to each other, in phase, and travel in the same speed. Therefore, (i), (ii), and (iii) are all correct, so E is correct.

2024 May Q10

#Electronics #Semiconductor

Solution: C

Moore’s law states that the number of transistors on a microchip doubles approximately every two years.

2023 Dec

Section A – Multiple-choice Questions

2023 Dec Q1

Electronics # Semiconductor

Solution: C

In a semiconductor subjected to an electric field, holes and electrons move in opposite directions. Electrons flows in opposite direction to the conventional current, while holes flows in the same direction as the conventional current. Therefore, C is correct.

2023 Dec Q2

Electronics # Semiconductor

Solution: E

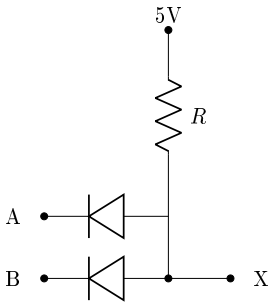
To form an n-type semiconductor using silicon, we dope it with an element that has more outer electrons than silicon, i.e., phosphorus, arsenic, or antimony. Phosphorus is ideal since its atomic size is similar to silicon, so E is correct.

2023 Dec Q4

Electronics # Diodes

Solution: C

A Si pn junction diode is a passive component, it cannot be used to implement `NOT` gates, so C is not true, therefore correct. Note that an `AND` gate can be implemented when connected in series, as shown below:



2023 Dec Q5

Electronics # BJT

Solution: E

A BJT can be considered as a voltage-controlled device, where the voltage across the base-emitter junction (V_{BE}) controls the current flowing from collector to emitter (I_C). Therefore, A is correct. The base current of a BJT is usually very small, so B is correct. A BJT contains two pn junctions (the base-emitter junction and the base-collector junction), so C is correct. The transfer characteristic of a BJT is exponential, so D is correct. Hence, all of the above statements are correct, so E is correct.

2023 Dec Q6

Electronics # BJT # MOSFET

Solution: C

Generally, when compared to MOSFETs, BJTs have higher transconductance, C is correct. On the other hand, MOSFETs consume less static power, have higher transistor density, and operate at higher frequencies, so A, B, and D are incorrect.

2023 Dec Q7

Electronics # Semiconductor

Solution: C

The bandgap energy E_g determines the conductivity of a material. The larger the E_g, the more energy is required to excite an electron from the valence band to the conduction band, so the material is less conductive. Hence, A and B are incorrect. Different E_g values correspond to different wavelengths of light that can be absorbed or emitted by the material, so D is incorrect. The built-in potential of a diode is affected by E_g, so E is incorrect. E_g does not determine the material's density, so C is correct.

By-year Index

By-topic Index