

ENTRANCE EXAMINATIONS 2017
Ph.D. (ELECTRONICS SCIENCE)

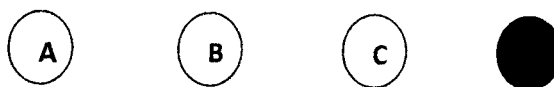
Marks: 80

Time: 2.00 hrs

Hall Ticket no:

Please read the following instructions carefully before answering the questions

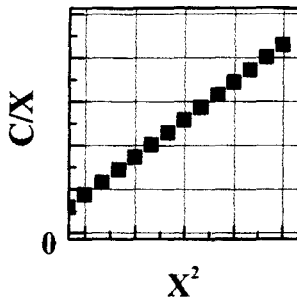
1. Write Hall Ticket Number on the OMR Answer Sheet given to you. Also write the Hall Ticket Number in the Space provided above.
2. This Question paper has TWO parts: PART A and PART B with PART A alone having negative marking for wrong answers. PART A consists of 20 questions with 2 marks for each correct answer and -0.66 mark for each wrong answer. PART B consists of 40 questions with 1 mark for each correct answer and no negative marking for wrong answers.
3. All questions are to be answered. Answers for these questions are to be entered in the OMR sheet, filling the circle representing the correct answer against the corresponding question. For example, if the answer to a question is D, it should be marked as below:



4. No additional sheets will be provided. Rough work can be carried out in the question paper itself. Rough work space is also provided at the end of the booklet.
5. Hand over the OMR answer sheet to the invigilator at the end of the examination.
6. Mobile phones, any type of calculator, log tables and other digital devices are NOT permitted inside the Examination Hall.
7. Values of some constants: Planck's constant, $h = 6.6 \times 10^{-34}$ Js;
speed of light, $c = 3 \times 10^8$ m/s; Boltzmann Constant, $k_B = 1.38 \times 10^{-23}$ m² kg s⁻² K⁻¹;
electron charge, $e = 1.6 \times 10^{-19}$ C
8. This book contains 18 pages including this cover sheet and a rough-work sheet.

PART A

1. The equation, slope and intercept that describe the graph below are



- A. $C = AX + BX^3$ where A is the y-intercept and B is the slope
 B. $C = AX + BX^2$ where A is the y-intercept and B is the slope
 C. $C = AX + B/(X^2)$ where B is the y-intercept and B is the slope
 D. $C = AX + BX^3$ where A is slope and B is the y-intercept
2. The current in the same branch of a circuit was measured independently by six observers and recorded as 12.8 mA, 12.2 mA, 12.5 mA, 13.1 mA, 12.9 mA, and 12.4 mA. The average deviation from the mean for this data is
- A. 0 mA
 B. 0.283 mA
 C. -0.283 mA
 D. 12.65 mA
3. A device process yields a specific feature size with a normal distribution about the designed value, with a standard deviation of $0.01\ \mu\text{m}$. If a million devices are fabricated, the number of devices with a deviation less than $0.03\ \mu\text{m}$ from the designed value for the feature size, is likely to be
- A. 997000
 B. 99700
 C. 680000
 D. 950000
4. If the range of a discrete set of n observations is zero, then the value of
- A. all observations is zero
 B. all observations is equal to the standard deviation
 C. all observation is equal
 D. only $n/2$ observations are equal

5. Two physical parameters M and F are related to each other by the equation

$$F = \sqrt{M + K/(2J)}$$

The value of J is known. An experiment is carried out in which the variation of F as a function of M is measured. Which of the following will yield the value of K graphically?

- A. A plot of F on y-axis and M on x-axis with K being estimated from the slope
- B. A plot of F^2 on y-axis and M on x-axis with K being estimated from the slope
- C. A plot of F on y-axis and M on x-axis with K being estimated from the x-intercept
- D. A plot of F^2 on y-axis and M on x-axis with K being estimated from the y-intercept

6. If all the students of a class are given 10 grace marks in a test, then the quantity that will remain unchanged is

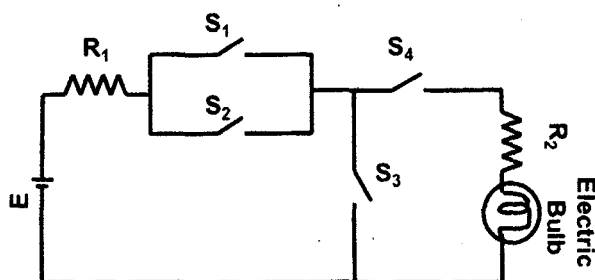
- A. Mean
- B. Mode
- C. Median
- D. Variance

Read the following passage and answer questions 7 and 8:

Popular Ohmic contact recipes for GaAs- based devices use Ni as an 'adhesion layer'. Inclusion of this Ni layer in the contact metallization structures results in a smooth film after annealing to achieve alloying and helps to obtain low contact resistances. However, studies show that adhesion of Ni to other metal layers has little to do with the smoothness of the alloyed contacts or the low contact resistances achieved.

7. What is the relation between smoothness of alloyed contacts, containing Ni, to the adhesion of Ni to other metal layers in a contact metal structure?
- A. No relation
 - B. A little correlation
 - C. Completely correlated
 - D. Cannot be determined from the passage
8. Which of the following is not true?
- A. Inclusion of Ni in the metal layer is one of the ways of ensuring smooth alloyed contacts to GaAs based devices.
 - B. If Ni is not included in the contact structure, then smooth alloyed contact structure will not be obtained
 - C. The use of the word 'adhesion layer' is not appropriate for the Ni layer in the context of alloyed contacts to GaAs based devices
 - D. Alloyed contacts with Ni layers are extensively used by researchers working on GaAs based devices.

9. The next number in the series: 8, 6, 9, 23, 87, is
- A. 128
B. 226
C. 324
D. 429
10. The correct alpha-numeric sequence in the blank space of the series B_2CD , _____, BCD_4 , B_5CD , BC_6D is
- A. B_2C_2D
B. BC_3D
C. B_2C_3D
D. BCD_7
11. The correct sequence of letters in the blank space of the series CMM, EOO, GQQ, _____, KUU is
- A. GRR
B. GSS
C. ISS
D. ITT
12. For which of the following switch combinations does the bulb in the circuit shown below glow?



- A. S1 Open, S2 Closed, S3 Open and S4 Closed
B. S1 Closed, S2 Open, S3 Closed and S4 Closed
C. S1 Closed, S2 Closed, S3 Open and S4 Open.
D. S1 Closed, S2 Closed, S3 Closed and S4 Closed.

13. A semiconductor is doped such that the doping concentration (N = Number of dopants per cm^3) decreases exponentially with depth (x) from the surface, as given by the equation: $N = Ae^{-Bx} + C$. The units of the constants, A , B , and C in this equation are, respectively
- A. cm^{-3} , cm^{-2} , cm^{-1}
 - B. cm^{-3} , cm , cm^{-3}
 - C. cm^{-3} , cm^{-1} , cm^{-3}
 - D. cm^{-1} , cm^{-2} , cm^{-3}
14. If a clock is started in the afternoon, then the angle through which the hours hand turns in 5 hours 10 minutes?
- A. 155°
 - B. 120°
 - C. 128°
 - D. 360°
15. In how many ways can a group of 5 men and 2 women be made out of a total of 7 men and 3 women?
- A. 21
 - B. 63
 - C. 55
 - D. 100
16. If $\log 2 = 0.3010$ and $\log 3 = 0.4771$, the value of $\log_5 512$ is
- A. 3.876
 - B. 2.24
 - C. 1.72
 - D. 4.25
17. What is the probability of getting a sum of 9 from two throws of a dice?
- A. $1/4$
 - B. $2/7$
 - C. $1/9$
 - D. $3/8$

18. One afternoon Umesh and Ramesh were standing face to face at a junction. If Ramesh's shadow was exactly to the right of Umesh, then which direction was Ramesh facing?
- A. East
 - B. West
 - C. North
 - D. South
19. A trader gives 20% discount on the maximum retailed price of an article and still makes a profit of 30%. If the cost price of this article is Rs. 1800, then what is the maximum retail price?
- A. Rs. 1800
 - B. Rs. 2340
 - C. Rs. 2160
 - D. Rs. 2925
20. In an examination, the number of students who appeared for the Physics, Chemistry and Mathematics tests are P , C , and M respectively. If $C:P = 8:3$ and $M:P = 2:5$ then, which of the following is false?
- A. $M < C$
 - B. $P < C$
 - C. $C < M$
 - D. $M < P$

PART B

21. Coaxial cables can support TEM modes. Which of the following is true?
- A. Yes, because they are cylindrical.
 - B. Yes, because there is a dielectric between the two conductors.
 - C. Yes, because the structure has two conductors.
 - D. No, because TEM mode of propagation is possible only in free space.
22. As seen from the input, a quarter wave transmission line terminated with an inductor will behave as
- A. a capacitor.
 - B. an inductor.
 - C. a resistor.
 - D. a transformer.
23. The cut-off frequency of a waveguide is 4 GHz. If it is operated at 3.8GHz, then
- A. it can be used as a filter.
 - B. it can be used as an isolator.
 - C. it can be used as an attenuator.
 - D. it cannot be used for the applications mentioned in A, B and C.
24. Which of the following phenomena represents the dependence of the phase velocity of an electromagnetic wave on the frequency of propagation in a medium?
- A. Diffraction
 - B. Polarization
 - C. Dispersion
 - D. Refraction

25. The x-component of the magnetic induction of a plane electromagnetic field in free space is represented by $B_x = \cos(z - ct)$. Which of the following is always true for the components of the electric field and the magnetic induction,

- A. $E_x = E_y = 0, B_y = B_z = 0$
- B. $E_y = E_z = 0, B_y = B_z = 0$
- C. $E_x = E_y = 0, B_y = 0$
- D. $E_z = 0, B_z = 0$

26. If \mathbf{H} is the intensity of applied magnetic field, \mathbf{B} is the magnetic induction, \mathbf{J} is the electric conduction current density, μ_0 is the magnetic permeability of free space and ∇ is the differential operator, then $\nabla \times \mathbf{H}$ in Amperes circuital law, equals

- A. \mathbf{J}
- B. $-\mathbf{J}$
- C. \mathbf{B}
- D. $\mu_0 \mathbf{J}$

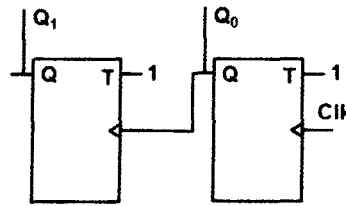
27. The analog voltage of a 4-bit Digital to Analog Converter (R-2R network) corresponding to binary input 1011 with a reference voltage of 5 V is

- A. 0.3125 V.
- B. 0.3437 V.
- C. 3.1252 V.
- D. 3.4375 V.

28. The capacity of a 2 KB Programmable Read only Memory is expanded to 8 KB. The number of additional address lines required in the expanded memory is

- A. 1
- B. 2
- C. 3
- D. 4

29. In the figure below, if the input clock frequency is 200Hz, then the frequency of the signal at the output of Q1 will be



- A. 50 Hz
- B. 100 Hz
- C. 200 Hz
- D. 800 Hz

30. The value of the expression $x = A\bar{B} + C(\bar{A}D)$ when A and B are set to logic 1 is

- A. $C\bar{D}$
- B. C
- C. \bar{D}
- D. $C + \bar{D}$

31. A 4-bit ring counter initialized with the binary 0100 will yield the decimal sequence

- A. 8, 4, 2, 1, ...
- B. 4, 2, 1, 8, ...
- C. 4, 8, 2, 1, ...
- D. 4, 2, 1, 0, ...

32. Which one of the following logic gates can be used as a controlled inverter?

- A. NOT
- B. OR
- C. AND
- D. XOR

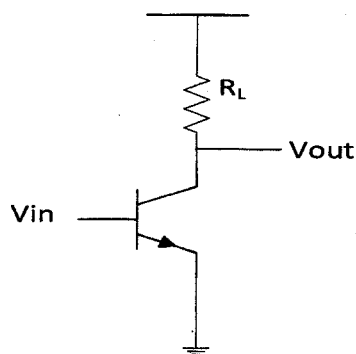
33. If $f(x) = \sqrt{ax} + \frac{a^2}{\sqrt{ax}}$ then the first derivative of $f(x)$ at $x = a$ is

- A. 0
- B. 1
- C. -1
- D. \sqrt{a}

34. If $z = x + iy$ and $|z + ai| = |z - ai|$ then the locus of z is
- the Y-axis
 - the X-axis
 - $x=y$
 - $x^2 + y^2 = 1$
35. The solution of $\frac{dy}{dx} + \frac{y}{3} = 1$ is
- $y = ce^{-x/3}$
 - $y = \frac{1}{3}x$
 - $y = e^{-x/3}$
 - $y = ce^{-x/3} + 3$
36. If $\vec{a} + \vec{b} + \vec{c} = 0$ and $|\vec{a}| = 7$, $|\vec{b}| = 5$, and $|\vec{c}| = 3$, then the angle between \vec{b} and \vec{c} is
- 30°
 - 45°
 - 60°
 - 90°
37. An avalanche photo diode operates in
- reverse bias at low voltage.
 - reverse bias close to breakdown.
 - forward bias below cut-in voltage.
 - forward bias above cut-in voltage.
38. If V_{GS} is the gate-source voltage, V_{DS} is the drain source voltage and V_t is the threshold voltage for an n-MOSFET in the saturation region, then the drain current I_D , is proportional to
- $V_{GS}^2 - V_t^2$
 - $V_{GS}^2 - V_{DS}^2$
 - $[2(V_{GS} - V_t)V_{DS} - V_{DS}^2]$
 - $(V_{GS} - V_t)^2$

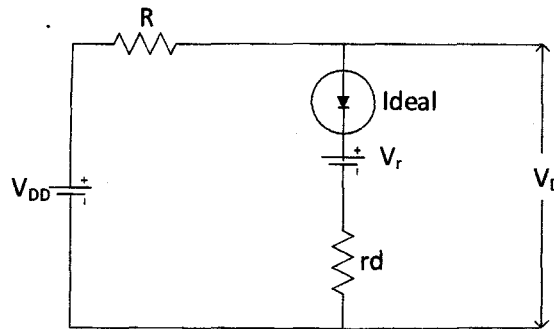
39. Early effect in BJT refers to
- A. Emitter width modulation by V_{CB}
 - B. Collector width modulation by V_{BE}
 - C. Base width modulation by V_{CB}
 - D. Base width modulation by V_{BE}
40. The reciprocal lattice of a face centered cubic lattice is
- A. a face centered cubic lattice.
 - B. a simple cubic lattice.
 - C. a hexagonal close packed lattice.
 - D. a body centered cubic lattice.
41. Aluminum has three valence electrons per atom, atomic weight of 0.027 kg/mol, density of 2700kg/m^3 , and conductivity of $3.5 \times 10^7 \text{ S/m}$. Assuming that all three valence electrons of each atom are free, then the electron mobility is (Avogadro number is 6.02×10^{23} atoms/mol and electron charge is $1.6 \times 10^{-19} \text{ C}$)
- A. $1.2 \times 10^{-3} \text{ m}^2/\text{V-s}$
 - B. $1.2 \times 10^{-3} \text{ cm}^2/\text{V-s}$
 - C. $2.1 \times 10^{-8} \text{ m}^2/\text{V-s}$
 - D. $1.2 \times 10^3 \text{ m}^2/\text{V-s}$
42. Which of the following characteristics are applicable to an emitter follower
1. Voltage gain is unity; 2. Power gain is high; 3. Phase difference between input and output is 0° ; 4. Input resistance is high
- A. 2, 3 and 4
 - B. 1, 2 and 3
 - C. 1, 3 and 4
 - D. 1, 2 and 4
43. A cascode amplifier is a combination of
- A. Common Gate Amplifier followed by Common Source Amplifier
 - B. Common Source Amplifier followed by Common Drain Amplifier
 - C. Common Source Amplifier followed by Common Gate Amplifier
 - D. Common Drain Amplifier followed by Common Source Amplifier

44. A BJT emitter coupled differential amplifier is biased with a tail current source I_{EE} whose internal resistance $R_{EE} \rightarrow \infty$. What is the common mode rejection ratio of the differential amplifier?
- A. $-\infty$
 B. 0
 C. -1
 D. -1/2
45. An NMOS has a threshold voltage $V_{th} = 0.4$ V. Its terminal drain, source, bulk and gate voltages are 2V, 0V, 0V and 1V, respectively. In which region is the NMOS operating?
- A. Ohmic
 B. Cut-off
 C. Sub-threshold
 D. Saturation
46. The BJT shown in the figure below is biased in active region. The cut-in voltage, $V_r = 0.6$ V, $\eta = 2$, and the voltage drop across R_L is 520 mV. What is the large signal voltage gain, V_{out}/V_{in} ? The volt-equivalent temperature V_T is 26mV.



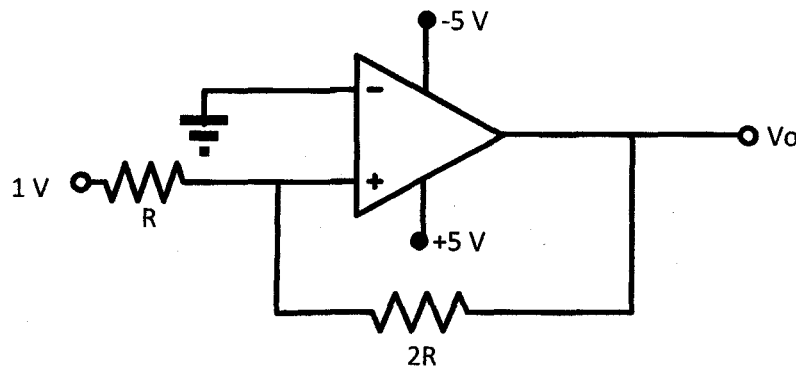
- A. -40
 B. -20
 C. -10
 D. -26

47. In the figure below $V_{DD}=5\text{ V}$, $V_r = 0.65\text{ V}$, $r_d = 20\ \Omega$, $R=1\text{ k}\Omega$. What is the value of V_D ?



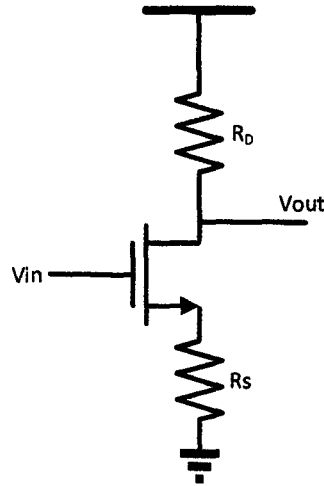
- A. 0 V
- B. 0.65 V
- C. 0.6 V
- D. 0.735 V

48. If in the circuit below the op-amp is an ideal op-amp, what is the output voltage, V_o ?



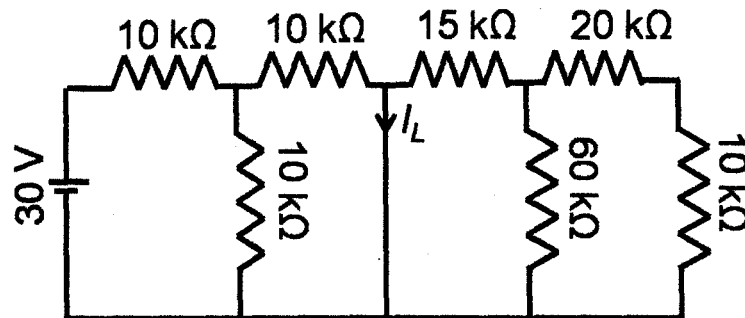
- A. -2 V
- B. -3 V
- C. +3 V
- D. +5 V

49. The common source amplifier shown in figure below is biased in the saturation region. What is the approximate voltage gain of the circuit if R_D and R_S values are $4\text{ k}\Omega$ and $1\text{ k}\Omega$ respectively?



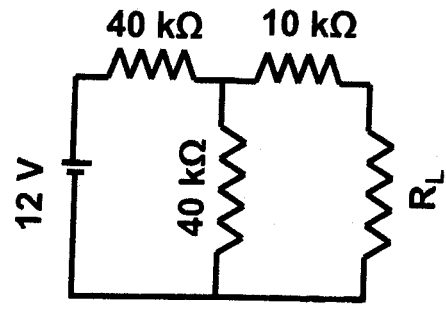
- A. -5
- B. -10
- C. -4
- D. -8

50. Calculate the current I_L flowing in the circuit shown in following figure



- A. ∞
- B. 1 A
- C. 0.5 A
- D. 2 A

51. In the circuit shown below, the value of load resistance (R_L) required to draw maximum possible power is

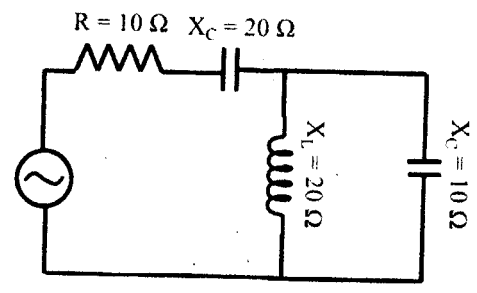


- A. 30 kΩ
- B. 40 kΩ
- C. 48 kΩ
- D. 6.6 kΩ

52. In a series circuit consisting of an a.c voltage source, a resistor and two reactive elements (A and B), the voltage across the resistor leads the applied voltage by 45° . Which of the following statements is correct about the circuit?

- A. It is necessary that both A and B are capacitors.
- B. At least one of A and B is an inductor with inductive reactance greater than any capacitive reactance.
- C. A and B are inductive and capacitive reactance's of equal magnitude.
- D. At least one of A and B is a capacitor with capacitive reactance greater than any inductive reactance.

53. The total impedance as seen by the source for the circuit shown below is



- A. 10 Ω
- B. 36.6 Ω
- C. $10 \Omega + j 40 \Omega$
- D. $10 \Omega - j 40 \Omega$

54. The input, $x(t)$, and output, $y(t)$, of a linear, time-invariant system are related by the differential equation

$$d^2y(t)/dt^2 + 3dy(t)/dt + 2y(t) = dx(t)/dt + x(t)$$

What is the impulse response of the system?

- A) $e^{-t}u(t)$
- B) $e^{-2t}u(t)$
- C) $(e^{-t} + e^{-2t})u(t)$
- D) $(e^{-t} - e^{-2t})u(t)$

55. The Discrete Fourier Transform of the sequence $x[0]=1$, $x[1]=j$, $x[n]=0$ for all other n is proportional to

- A. $X(0)=(1+j)/2$, $X(1)=(1-j)/2$
- B. $X(0)=(1-j)/2$, $X(1)=(1+j)/2$
- C. $X(0)=1/2$, $X(1)=-j/2$
- D. $X(0)=+j/2$, $X(1)=1/2$

56. Which one of the following transfer functions, $H(s)$, represents a system that is not stable

- A. $(s+2)/(s+1)$
- B. $(s+2)/(s-1)$
- C. $1/[(s+1)(s+2)]$
- D. $(s+1)(s-1)$

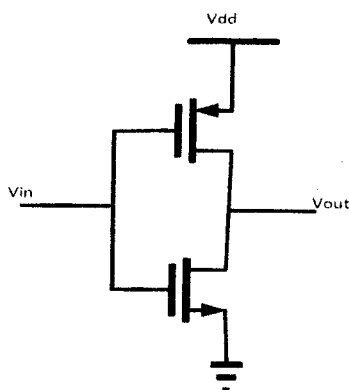
57. In a Smith chart, a circle of arbitrary radius is drawn such that its centre coincides with the centre of the chart. This circle represents

- A. the locus of all points with the same impedance
- B. a circle of constant reactance
- C. the values of impedance at all points along a terminated transmission line
- D. a circle of constant resistance

58. A piece of Si is doped such that the concentration of free electrons is $1.5 \times 10^{15} \text{ cm}^{-3}$. The concentration of holes in this sample if the intrinsic carrier concentration, n_i of Si is $1.5 \times 10^{10} \text{ cm}^{-3}$ at room temperature (300 K) is

- A. $1.5 \times 10^{10} \text{ cm}^{-3}$
- B. $1.5 \times 10^5 \text{ cm}^{-3}$
- C. $2.25 \times 10^{20} \text{ cm}^{-3}$
- D. $2.25 \times 10^8 \text{ cm}^{-3}$

59. In the balanced inverter circuit shown below, a capacitor of 1pF is connected between the output node, V_{out} and ground. The ON resistance of the PMOS is $2 \text{ k}\Omega$. The time taken for the output to transit from $0V$ to $V_{dd}/2$, when the input goes from high to low is,



- A. 0.69 ns
- B. 0.69 ps
- C. 1.38 ps
- D. 1.38 ns

60. Which of the following is the band gap energy of a material used to fabricate an LED that emits blue light of wavelength $\sim 410 \text{ nm}$.

- A. 1 eV
- B. 2 eV
- C. 3 eV
- D. 4 eV