زانكۆی پۆلیتەكنیكی هەولێر
ERBIL POLYTECHNIC UNIVERSITY

Module (Course Syllabus) Catalogue

2023-2024

College/ Institute	Erbil Technology College				
Department	Information& Communication Technology Engineering Department				
Module Name	Electronics				
Module Code	ELE301				
Semester	3rd Semester				
Credits	6				
Module type	Prerequisite	Core	y	Assist.	
Weekly hours	4	4			
Weekly hours (Theory)	(2) hr Class	(3) hr Workload			
Weekly hours (Practical)	(2) hr Class	(1) hr Workload			
Lecturer (Theory)	Sevan Hussein Ali				
E-Mail & Mobile NO.	sevan.ali@epu.edu.iq				
Lecturer (Practical)	Sevan Hussein Ali				
E-Mail & Mobile NO.	sevan.ali@epu.edu.iq				

Course Book

Course Description	Electronics
Course objectives	This course is designed to help students. Understand the fundamental electrical concepts and abstractions that underpin the creation of electronic systems. Lumped circuit models, digital circuits, and operational amplifiers are examples of these. Using oscilloscopes, multimeters, and signal generators, construct circuits and measure circuit variables. Compare the measurements to the projected behavior of mathematical models and explain the differences. Recognize the connection between the mathematical depiction of circuit behavior and the associated real-world effects. Understand the practical importance of the systems taught throughout the course.
Student's obligation	Missed classes, including quizzes and scheduled assignments, will not be paid. Students will be penalized for missing classes with quizzes unless a legal document or allowed leave is produced that explains the reason for the absence. However, the absent student is responsible for making up the missed lecture.
Required Learning Materials	Multisim simulation software
Assessment scheme	16% Mid Term (Theory and practical) 4% Quiz 40% Assignment (report, paper, homework, seminar..) 25% final practical 15% final theory
Specific learning	By the end of this course student will be able to:

outcome:	- To describe how the fundamental electronic devices are put together. - To create applications utilizing the fundamental electronic components. - The capacity to comprehend and evaluate digital and linear electrical circuits. - the students will possess a foundational understanding of electronics concerning characteristics of matter, optics, acoustics, etc., and they will utilize these basic concepts to address real-world issues concerning materials utilized in engineering applications. - Able to build circuits using electronics. - Capable of examining electrical circuits - Appropriate in using circuit theorems. - Capable of doing AC and DC circuit analysis
Course References:	1. Electronic, circuit theory, semiconductor materials, diodes, transistor, amplifier 2. ROBERT BOYLESTAD, ELECTRONIC DEVICES AND CIRCUIT THEORY, 7th edition. 3. Electronics fundamental circuits, devices and applications, Thomas L. Floyd, 8th Edidtion

Course topics (Theory)	Week	Learning Outcome

Explain briefly on material	1	Recognizing Various Material Types
P-type and N-type semiconductor ,PN Junction .	2	Ability to know the difference between p- type and n-type semiconductors
Semiconductor Theory ,FW and reverse biased , current flow at FW and Reverse biased.	3	Ability to understand where does the FW and Reverse biased are work and know how to calculate the current for the both
Half-Wave rectifiers	4	Half wave rectifier and its applications
Full –Wave rectifiers c Science calculating current , Average voltage and frequency.	5	Full wave rectifier and its applications
Equivalent Circuit of PN junction ,junction	6	What is PN junction and how does it work? Calculation the **I&V** for the PN junction
Midterm exam	**7&8**	
capacitor (CJo)	9	Understand the nature of capacitors and how to determine a quantity that measures their ability to store charges Understand the sources of electric potential and calculate the amount of energy stored in a capacitor Be able to analyze capacitors connected in a network
Filters ,types of Filters (LC and RC) ,output Ripple voltage>	10	Ability to **learn** the basic of these circuits, the theory behind them ... A **RC**/RL/RLC circuit can be used as a **filter**, oscillator and much more it is not ... Where, VB is the battery

		output current of the circuit. .... **LC** circuit; Variable tunes circuits; Oscillator circuits; **Filtering** circuit s
Zener diode, construction of Zener diode	11	Ability to Use devices in real life, Design small signal model for **BJT, FET,** Analyze and Design a few applications using these devices Design and construct a simple **DC** power supply.
Biploar Transistors, construct, symbol and property.	12	Understanding of the behavior of **bipolar junction transistor** circuits using a variety of different tasks ... on the **learning** and teaching of content covered in such ... of emitter follower circuits,circuits with **an output**.
Types of configuration are used for transistor (CE,CB and CC).	13	learn about Different Configurations of Transistors. Since a **BipolarJunction** Transistor is a **3-terminal** device, there are three differentconfiguration of Transistors possible with BJTs. Understanding these different configurations of transistors

Application of transistor as a Switch.	14	Learn about using a transistor as a **SWITCH**
Final term exam	**15 &16**	
Practical Topics	**Week**	**Learning Outcome**
Diode (pn) junction characteristics in the forward and Reverse bias.	1	Calculating I&V for FW and Reverse biased
Half wave rectifier.	2	Plotting input and output wave form for a half wave rectifier
Full wave rectifier by using (2diodes).	3	Plotting input and output wave form for a full wave rectifier (2diodes)
Half wave rectifier with filter circuit.	4	Plotting input and output wave form for a half wave filtered rectifier
Full wave rectifier with filter (2diode) circuit.	5	Plotting input and output wave form for a full wave filtered rectifier (2diodes)
Voltage doubler by using half wave rectifier. Voltage doubler by using full wave rectifier.	6	To design and study the voltage doubler and plotting the input and output wave form
Midterm exam	**7 & 8**	
Static characteristics of zener diode.	9	The working principle of Zener diode.
Voltage regulator by using zener diode.	10	**Zener diodes** are widely used as **voltage** reference s and as shunt **regulators** to regulate the **voltage** across small circuits. When

		connected in parallel with a variable **voltage** sour ce so that it is reverse biased, a **Zener** **diode** conducts when the **voltage** reaches the **diode's** reverse breakdown **voltage**.
CE Transistor input characterstics.	11	Ability to know the transistor biasing

CE transistor output characteristics	12	Ability to know the common emitter characterizes and common base amplifier work
LED characteristics	13	Ability to know the common emitter amplifier work
Photo diode characteristics	14	Ability to know the common collector amplifier work
Final term exam	**15 & 16**	

Questions

Q1/ A- Explain Briefly:

1- Extrinsic Semiconductor.
2- Light emitting diode.

Q1/ B- Fill in the blanks with the appropriate word(s).

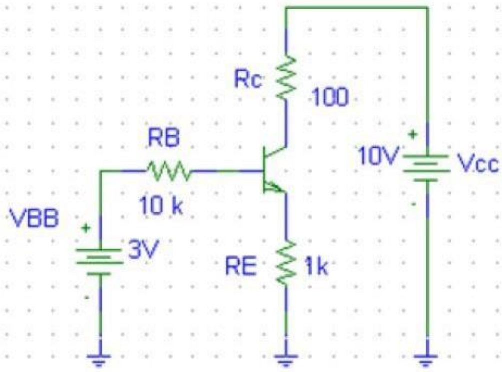
1- In case of Short Circuit, ---------- Current will flow in the Circuit.
2- Band gap Energy for Germanium at Room Temperature (300°K) is -------.
3- Formation of a junction between a sample of P-type and N-type material causes ----------- action.
4- ------- Provide an adjustable d.c. output voltage by controlling the phase at which devices are turned on.
5- One of the most common uses for transistors in an electronic circuit is as ----

Q2/ A- Explain briefly:

1- For BJT npn transistor, how the electrons get enough momentum to cross the Base into the Collector?
2- Why a series resistor is necessary when a diode is forward-biased?
3- What is the main difference between standard diode, and a zener diode?

Q2/ B- Determine the equilibrium electron and hole concentration in silicon for the following conditions: T= 300K, Nd= $3*10^{16}cm^{-3}$, Na= 0.

Q3/ A- Determine whether or not the transistor in figure below is in saturation region? Assume $V_{CE(sat)}$= 0.2 V



no. 1

Q3/ B-What should be the capacitance to appropriately smooth a 24V_{PP} ac signal, 60H and 1A?

Q4/ A- for the Zener diode of the network below determine (a) V_L, V_R, I_Z, and P_Z. (b Repeat part (a) with RL = 3 kΩ.

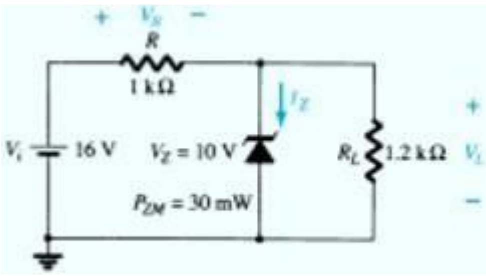
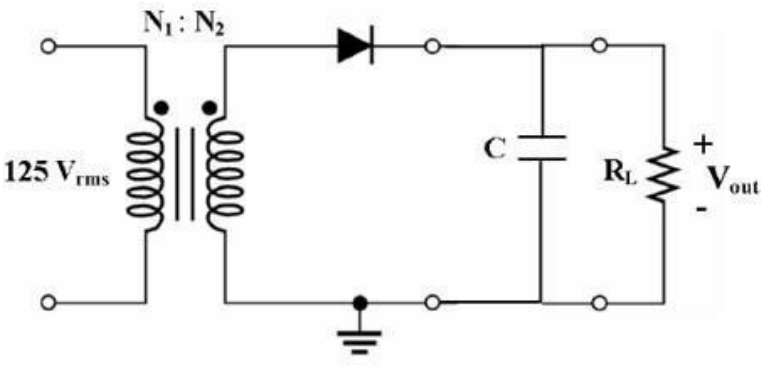


Figure no. 2

Q4/ B- What is **FET**? What's the difference between **FET** and **BJT**? How many types o **FET** do we have? Which is the more used one?

Q5/ Consider the filtered half-wave rectifier in Figure below, assume f= 60Hz and V_{on}= 0.7V. Given the following conditions: a. V_{DC}= 15V when R_L= 1KΩ, b. V_{DC}= 20V when R_L= 1.5KΩ determine:

1- Maximum ripple Voltage (V_M)
2- Turn ration (N1:N2)



.2

Answers:

Q1/ A-

1- The Transistor is a three-terminal, semiconductor device. It's possible to control electric current or voltage between two of the terminals (by applying an electric current or voltage to the third terminal). The transistor is an active component. With the Transistor we can make amplification devices or electric switch. Configuration of circuit determines whether the transistor will work as switch or amplifier
2- An intrinsic semiconductor is one which is made of the semiconductor material in its extremely pure form. Examples of such semiconductors are: pure germanium and silicon which have forbidden energy gaps of 0.72 eV and 1.1 eV respectively. The energy gap is so small.
3- The net flow of the electrons and holes in a semiconductor will generate currents. The process by which these charged particles move is called transport. The two basic transport mechanisms in a semiconductor crystal: Drift and Diffusion.
4- It is value for forward biased junction depends on the magnitude of forward dc current.
5- The load regulation of a power supply is defined as the percentage change in output voltage when the load current is increased from zero to full rated output.

Q1/ B-

1. Reverse,
2. increase,
3. temperature,
4. Minority, Majority,
5. Inversely

Q2/ A-

1- For BJT npn transistors, A- Base is thin B- Emitter region is n+ (heavily doped) so electrons get enough momentum to cross the Base into the Collector
2- A series resistor need to limit the current through a forward bias diode then diode with not damage because diode itself has a little resistance
3- A standard diode has a reverse bias threshold which is very large. It is designed to only work in one direction (the forward bias) at a threshold of about 0.6. A zener diode is designed to work in the reverse bias direction and has a cutoff threshold which is much lower and known. Zener diodes are rated in terms of the voltage at which they cutoff in the reverse bias

Q2/ B-

Holes concentration is given by

$$p_0 = \frac{N_a - N_d}{2} + \sqrt{\left(\frac{N_a - N_d}{2}\right)^2 + n_i^2} \quad \ldots\ldots (1)$$

Here N_d is donor concentration, N_a is acceptor concentration and n_i is the intrinsic carrier concentration at given temperature.

Substitute $10^{15}\,\text{cm}^{-3}$ for N_d, $4\times10^{15}\,\text{cm}^{-3}$ for N_a and $1.5\times10^{10}\,\text{cm}^{-3}$ for n_i at 300 K.

$$p_0 = \frac{4\times10^{15}\,\text{cm}^{-3} - 10^{15}\,\text{cm}^{-3}}{2} + \sqrt{\left(\frac{4\times10^{15}\,\text{cm}^{-3} - 10^{15}\,\text{cm}^{-3}}{2}\right)^2 + \left(1.5\times10^{10}\,\text{cm}^{-3}\right)^2}$$

$$= 1.5\times10^{15}\,\text{cm}^{-3} + 1.5\times10^{15}\,\text{cm}^{-3}$$

$$= 3\times10^{15}\,\text{cm}^{-3}$$

And also electron concentration

$$n_0 = \frac{n_i^2}{p_0}$$

Substitute $1.5\times10^{10}\,\text{cm}^{-3}$ for n_i and $3\times10^{15}\,\text{cm}^{-3}$ for p_0

$$n_0 = \frac{\left(1.5\times10^{10}\,\text{cm}^{-3}\right)^2}{3\times10^{15}\,\text{cm}^{-3}}$$

$$= 7.5\times10^{4}\,\text{cm}^{-3}$$

Hence holes concentration is $\boxed{3\times10^{15}\,\text{cm}^{-3}}$ and electron concentration is $\boxed{7.5\times10^{4}\,\text{cm}^{-3}}$.

Q3/ A-

$$V_{CC} = I_C R_C + V_{CE} + I_E R_E = I_C R_C + V_{CE} + \frac{I_C}{\alpha_{DC}} R_E$$

$$\alpha_{DC} = \frac{\beta_{DC}}{\beta_{DC}+1} = \frac{50}{51} = 0.98$$

$$V_{CC} = I_C R_C + V_{CE} + \frac{I_C}{0.98} R_E = I_C R_C + V_{CE} + 1.02 I_C R_E$$

$$I_C = \frac{V_{CC} - V_{CE}}{(R_C + 1.02 R_E)}$$

$$I_{C(sat)} = \frac{V_{CC} - V_{CE(sat)}}{R_C + 1.02 R_E} = \frac{10 - 0.2V}{1 + 1.02} 4.8mA$$

$$V_{BB} = I_B R_B + V_{BE} + I_E R_E = I_B R_B + 0.7 + (I_B + 50 I_B) R_E$$

$$I_B = \frac{V_{BB} - 0.7}{R_B + 51 R_E} = \frac{3 - 0.7V}{(10 + 51 * 1) K\Omega} = 0.038mA$$

$$I_C = \beta_{DC} I_B = 50 * 0.038mA = 1.9mA$$

As $I_C < I_{C(sat)}$ $\therefore$ This transistor is operated in active mode.

Q3/ B-

$$C = \frac{I}{2 \cdot Vr \cdot f} = \frac{1A}{2 \cdot 0{,}1 \cdot 12V \cdot 60Hz} = 6950 \mu F$$

Q4/ A-

$$V = \frac{R_L V_i}{R + R_L} = \frac{1.2\ \text{k}\Omega(16\ \text{V})}{1\ \text{k}\Omega + 1.2\ \text{k}\Omega} = 8.73\ \text{V}$$

$$V = \frac{R_L V_i}{R + R_L} = \frac{3\ \text{k}\Omega(16\ \text{V})}{1\ \text{k}\Omega + 3\ \text{k}\Omega} = 12\ \text{V}$$

$$V_L = V_Z = \mathbf{10\ V}$$

$$V_R = V_i - V_L = 16\ \text{V} - 10\ \text{V} = \mathbf{6\ V}$$

$$I_L = \frac{V_L}{R_L} = \frac{10\ \text{V}}{3\ \text{k}\Omega} = 3.33\ \text{mA}$$

$$I_R = \frac{V_R}{R} = \frac{6\ \text{V}}{1\ \text{k}\Omega} = 6\ \text{mA}$$

$$I_Z = I_R - I_L \text{ [Eq. (2.18)]}$$
$$= 6\ \text{mA} - 3.33\ \text{mA}$$
$$= \mathbf{2.67\ mA}$$

$$V_L = V = \mathbf{8.73\ V}$$

$$V_R = V_i - V_L = 16\ V - 8.73\ \text{V} = \mathbf{7.27\ V}$$

$$I_Z = \mathbf{0\ A}$$

$$P_Z = V_Z I_Z = V_Z(0\ \text{A}) = \mathbf{0\ W}$$

$$P_Z = V_Z I_Z = (10\ \text{V})(2.67\ \text{mA}) = \mathbf{26.7\ mW}$$

Q4/ B-

- Three Types of Field Effect Transistors
  - MOSFET (metal-oxide-semiconductor field-effect transistors)
    - Enhancement mode
    - Depletion mode
  - JFET (Junction Field-effect transistors)

- The more used one is the n-channel enhancement mode MOSFET, also called NMOS

- Similar to the BJT:
  - Three terminals,
  - Control the output current

BJT Terminal	FET Terminal
Base	Gate
Collector	Drain
Emitter	Source

Q5/

For the half-wave rectifier; $f_r = f_{line} = 60$ Hz

Here, (1) $V_{DC} = 15$ V when $R_L = 1$ kΩ

(2) $V_{DC} = 20$ V when $R_L = 1.5$ kΩ

$$V_{DC} = V_M\left(1 - \frac{1}{2f_r RC}\right)$$

$$\therefore \quad 15 = V_M \times \left(1 - \frac{1}{(2\times 60\,\text{Hz})(1\times 10^{-3}\,\Omega)(C)}\right) \qquad (1)$$

$$20 = V_M \times \left(1 - \frac{1}{(2\times 60\,\text{Hz})(1.5\times 10^{-3}\,\Omega)(C)}\right) \qquad (2)$$

From (1) and (2): $C = 1.67\times 10^{-5}$ F or $16.7\,\mu F$

A)

$$15 = V_M \times \left(1 - \frac{1}{(2\times 60\,\text{Hz})(1\times 10^{-3}\,\Omega)(1.67\times 10^{-5}\,\text{F})}\right)$$

$$\therefore V_M \cong 30\text{ V}$$

B) From Figure 3.85,

$$V_{\sec(p)} - 0.7 = V_M$$

$$\therefore \quad V_M = 30.7\text{ V}$$

$$V_{pri(p)} = \sqrt{2}\times 125 = 176.78\text{ V(p)}$$

$$\therefore \quad \frac{N_1}{N_2} = \frac{V_{pri(p)}}{V_{\sec(p)}} = \frac{176.78}{30.7} = 5.76$$

Extra notes:

External Evaluator

This course book has to be reviewed and signed by a peer. The peer approves the contents of the course book by writing the following sentences:

- This course book is written according to the university template.
- The course teacher put all necessary information in the course book.
- The course teacher follows the syllabus in writing the course book.

Peer reviewer name: Dr. Ilham Kadhim Onees

Academic title : Lecturer