



Department of Physics

College of science

University of Salahaddin

Detector

Course Book – (3rd year Medical Physics)

Assist. Lecturer's Samira Yousif

Academic Year: 2022- 2023

Course Book

1. Course name	Detector
2. Lecturer in charge	Samira yousif Asoka
3. Department/ College	Physics /science
4. Contact	e-mail: samira.asoka@su.edu.krd Tel: (optional)
5. Time (in hours) per week	Theoretical: 2hr
6. Office hours	All days(9Am-3Pm)
7. Course code	
8. Teacher's academic profile	<ul style="list-style-type: none"> - I awarded B.Sc. in physics (College of Science) in 1989 Salahaddin University. - M.Sc. in 2007 (Salahaddin University-Erbil). - Assist. Lecturer from 2007 till now.
9. Keywords	photodetector, diode, photo diode, Photo emissive Detectors, Bolometers, CCD, Photography.
10. Course overview:	
<p>The goal of studying detector is to teach students basic concepts about the detection of light in the entire optical wavelength range from visible light to thermal infrared radiation and also physical understanding of detector operation, type of detector such as Intrinsic Photoconductors, Extrinsic Photoconductors, Extrinsic Doped Silicon Detectors, so the student can keep place with technological development nowadays.</p>	
11. Course objective:	
<p>At the end of the course the student will have acquired the following skills:</p> <ul style="list-style-type: none"> - will know the main mechanisms detection of light. - will be able to understand how to use detector to obtain a measurable signal through electronic devices. - will know the main types of detector - will know how to combine the different detection techniques to determine the type of detector under measurement. 	
12. Student's obligation	
<ul style="list-style-type: none"> -The students should attend all the lectures. - The student must be participating in the debate and solving problem and home works. 	
13. Forms of teaching	
<p>PowerPoint slides, white board are used to explain the lectures There will be a review at end of every chapter</p>	
14. Assessment scheme	
Quizzes, in Class Participations and student activity	10 %
One exam during the course	30 %
Final Exam	60 %

15. Student learning outcome:

- Students will be able to demonstrate knowledge of principles of detector, mathematics, diode, semiconductor detector, properties and type of semiconductor that used for detection of light . different kinds of radiation detectors

16. Course Reading List and References:

- Key references

- Detection of Light George H. Rieke / third edition

REFERENCs BOOKS: Radiation Detection and Measurement Third Edition Glenn E Knoll

Any related- on line references

17. The Topics:

Chapter	Week	Object	Sections
1	1, 2	Introduction	Radiometry, Detector Types, Performance Characteristics of detector such as spectral response , spectral band width , linearity, quantum efficiency , noise and time response
2	3,4,5	Photodetector basics	Solid State Physics, Intrinsic Photoconductors, Extrinsic Photoconductors, Example: Design of a Photoconductor
3	6,7,8	Infrared photodetector	Photodiodes. Extrinsic Doped Silicon
5	9,10	Charge Coupled Devices	Basic Operation, Performance at Faint Light Levels, Quantum Efficiency and Spectral Range, Optical/Infrared Detector Test Procedures
6	11,12	Other Detector	Photography, Photo emissive Detectors, Quantum Well Detectors ,Resolving Detectors
8	13,14	Bolometer	Basic Operation of Bolometer, Room Temperature Thermal Detectors 2, Cryogenic Semiconductor Bolometers, Superconducting Bolometers, Bolometer Construction Components

18. Practical Topics (If there is any)

19. Examinations:

Q1/A/ Fill in the blank (20 point)

- 1- ----- is the degree to which the output signal is proportional to the number of incoming photons that were received to produce the signal.
- 2- -----is the amount of light, emitted by an area of surface of a radiating body.
- 3- The fundamental noise limitation for any detector is the noise that arises because -----
- 4- detector characteristics are -----.

- 5- In general, the ----- is proportional to the mean time between collisions.
- 6- The increase in pseudo-minority impurities can increase the -----and result in an increase - -----.
- 7- The reduction in frequency response due to dielectric relaxation is inversely proportional to -----, and the effect becomes important at -----.
- 8- The ----- describes this degradation succinctly in terms of the number of photons that could produce an output signal with an equivalent ratio of signal to noise if no degradation occurred
- 9- The concentration of electrons in the conduction band given by -----
- 10-----must have large volumes to achieve reasonable quantum efficiencies.

Q1/b / Calculate quantum efficiency for a detector operating at a wavelength of 800 nm that is 0.1 mm thick and made of material with $n = 3.6$ and $\alpha(800\text{nm}) = 100 \text{ cm}^{-1}$ (15 point)

Q2/Answer the following (30 point)

- 1- A detector operating at 800nm produces an output current of 80 A for an incident light beam of power 800 W Calculate the quantum efficiency and responsivity of the detector
- 2- A 100W light source emits uniformly in all direction. A photodetector having a circular active area whose diameter is 1 cm is placed 1 m away from the source normal to the incident light if the responsivity of the photodetector is 0.4 A/W . calculate the photocurrent generated in the detector.
- 3- write about detector types.

Q3/A/ choose the correct answer of the following (15 point)

- 1- Cut off frequency of a photo detector depends on
 - a) Electrode capacitance
 - b) pressure
 - c) volume
 - d) temperature
- 2- The ratio of the number of emitted electrons to the number of absorbed photons is called
 - a) Gain
 - b) injection efficiency
 - c) Quantum efficiency
 - d) Current gain.
- 3- Johnson noise arises due to
 - a) fluctuation in electric field
 - b) fluctuation in magnetic field
 - c) the random motion of carriers
 - d) change in polarization
- 4- _____ always leads to the generation of a hole and an electron.

- a) Repulsion b) Absorption c) Dispersion d) Attenuation

5- GaAs has band gap energy of 1.93 eV at 300 K. Determine wavelength above which material will cease to operate.

- a) 2.431×10^{-5} b) 6.424×10^{-7} c) 6.023×10^3 d) 7.234×10^{-7}

6- Determine Responsivity of photodiode having o/p power of $3.55 \mu\text{m}$ and photo current of $2.9 \mu\text{m}$.

- a) 0.451 b) 0.367 c) 0.982 d) 0.816

Q3/2- a photodetector has quantum efficiency of 65% at wavelength $0.9 \mu\text{m}$, the load resistance is $4\text{k}\Omega$, the incident power at this wavelength is 200nW and band width is 5MHz , determine the G-R noise, and thermal noise at a temperature of 20°C (20point)

$$h = 6.626 \times 10^{-34} \text{ J s} \quad c = 3 \times 10^8 \text{ m/s} \quad e = 1.602 \times 10^{-19} \text{ C} \quad K = 1.380 \times 10^{-23} \text{ J/K}$$

20. Extra notes:

1) This course is suitable for the 3rd year students (B.Sc.), it's very difficult for the 1st and 2nd years B.Sc.

2) This course is useful in different fields to get works in private sector.

21. Preview

پیداچونہوہی ھاوہل

This course book has to be reviewed and signed by a peer. The peer approves the contents of your course book by writing few sentences in this section.

(A peer is person who has enough knowledge about the subject you are teaching, he/she has to be a professor, assistant professor, a lecturer or an expert in the field of your subject).

ئەم كۆرسىۋو كە دەبىت لەلايەن ھاوہلئىكى ئەكادىمىيەو سەير بىكرىت و ناوہرۆكى بابەتەكانى كۆرسەكە پەسەند بىكات و جەند ووشەپەك بنووسىت لەسەر شىاوى ناوہرۆكى كۆرسەكە و واژووى لەسەر بىكات.
ت پلەى زانستى لە مامۇستا كەمتر نەبىت. [ھاوہل ئەو كەسەپە كە زانىارى ھەبىت لەسەر كۆرسەكە و دەبى