حلول الاسئلة النموذج ٣

Q1

A-

1- True.

2- False.

3- False.

4- True.

Q1

B-

$$m = \Delta I / I_o P$$

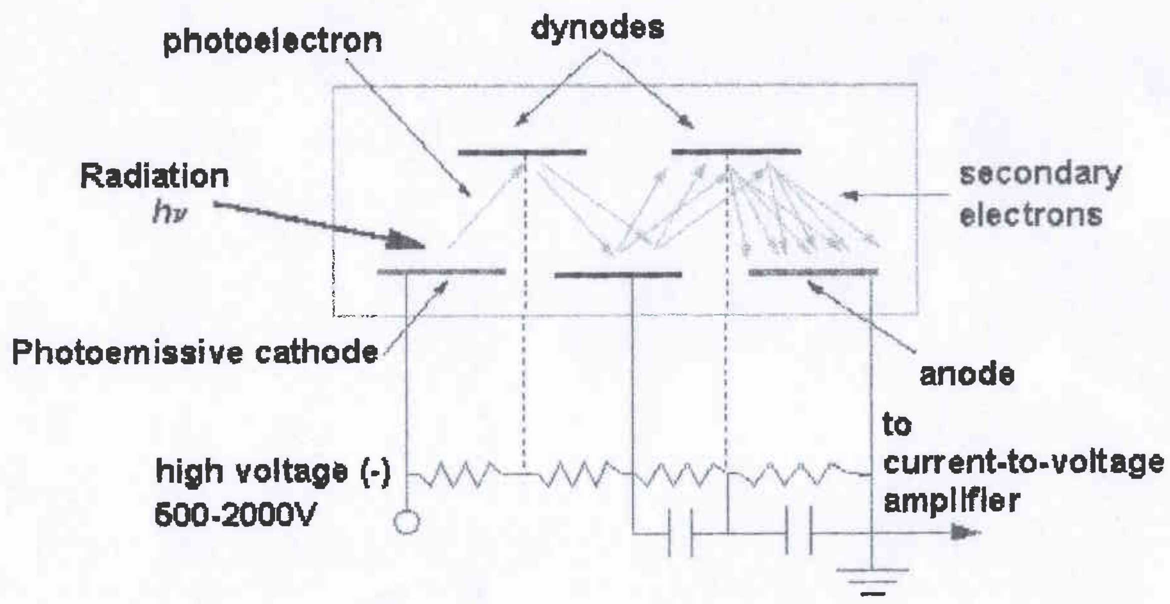
$$S = q I_o R m$$

$$m = 0.6\ mA / 3\ nA \times 0.002 = \frac{0.2}{0.002} = 0.1 \times 10^{3}$$

$$S = 0.2 \times 3\ nA \times 1 \times 10^{-3} \times 0.1 \times 10^{3} = 0.06\ mA$$

Q2A

Photomultiplier Tubes (PMTS)



Photomultiplier Tubes (PMTS) are light detectors that are useful in low intensity applications such as fluorescence spectroscopy. Due to high internal gain, PMTs are very sensitive detectors.

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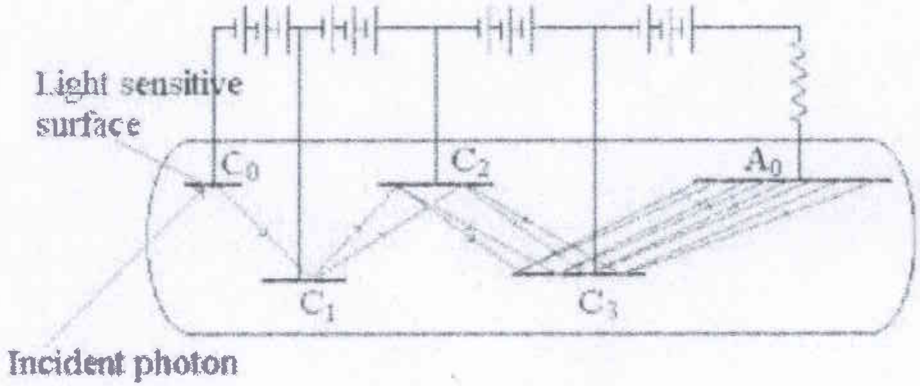
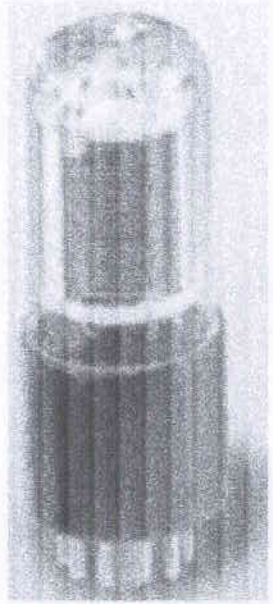
Q2A

Photomultiplier Tubes





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Secondary emission of electrons due to high velocity electrons
- Amplification is very high
- Used in single photon counter

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Interference of two waves

When two monochromatic waves of complex amplitudes U1(r) and U2(r) are superposed, the result is a monochromatic wave of the Same frequency and complex amplitude,

$$U(r) = U_1(r) + U_2 (r)$$

Let Intensity $I_1 = |U_1|^2$ and $I_2 = | |U_2|^2$ then the intensity of total waves is

$$I=|U|^2 = |U_1+U_2|^2 = |U_1|^2 + |U_2|^2 + U_1^* U_2 + U_1 U_2^*$$

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Q2B

Interference of two waves

Let $U_1 = I_1^{0.5} e^{j\phi_1}$ and $U_2 = I_2^{0.5} e^{j\phi_2}$ Then

$$I = I_1 + I_2 + 2(I_1 I_2)^{0.5} COS\phi$$

Where $\phi = \phi_2 - \phi_1$

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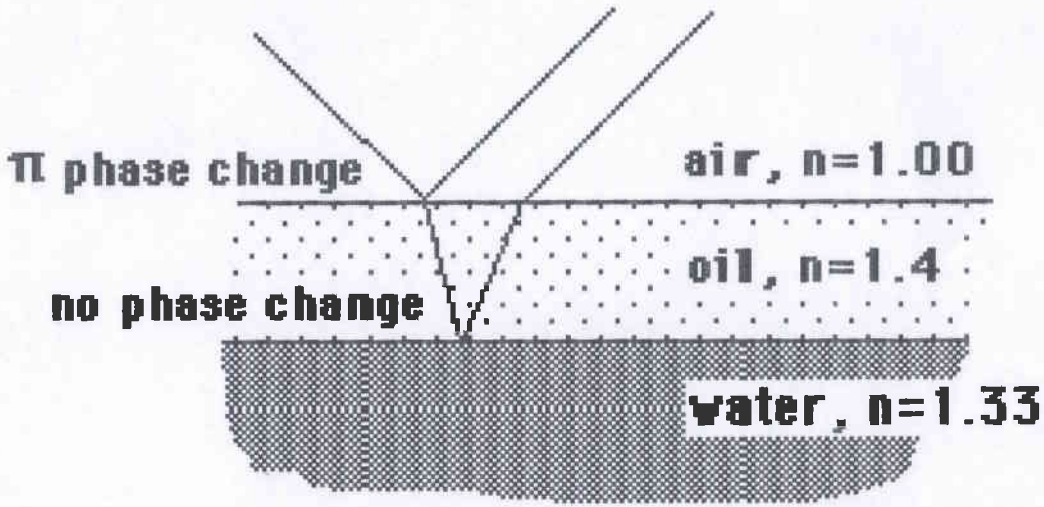
O3A

Film thickness Measurement



This phase change is important in the interference which occurs in thin films, the design of anti-reflection coatings, interference filters, and thin film mirrors.

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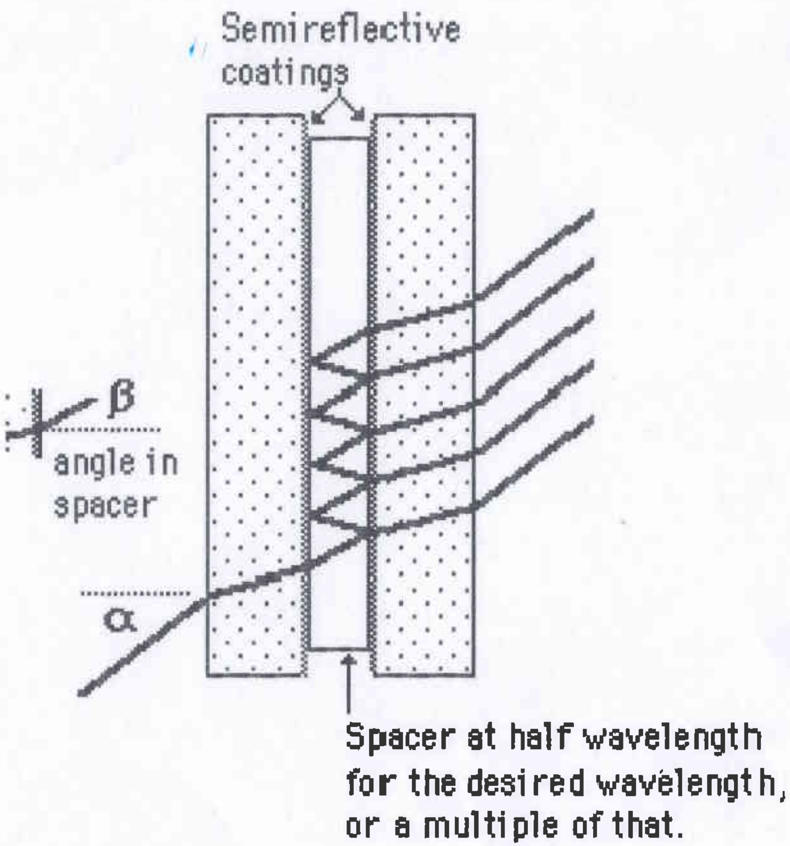
O3 A

Interference Filters



Thickness calculated from the interference condition:

$$d = \frac{\lambda}{2n\cos\beta}$$

The passed wavelength is given by

$$\lambda = \lambda_0 \sqrt{1 - \frac{\sin^2\alpha}{n^2}}$$

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6) 3/13

The term *1/f noise* (pronounced *one over f*) is used to describe a number of types of noise that are present when the modulation frequency f is low. This type of noise is also called excess noise because it exceeds shot noise at frequencies below a few hundred Hertz.

The mechanisms that produce $1/f$ noise are poorly understood. The noise power is inversely proportional to f, the modulation frequency. This dependence of the noise power on modulation frequency leads to the name for this type of noise.

To reduce $1/f$ noise, an optical detector should be operated at a reasonably high frequency, often as high as 1000 Hz. This is a high enough value to reduce the contribution of $1/f$ noise to a small amount.

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044A

Types of Optical Detectors

Photon detectors may be further subdivided according to the physical effect that produces the detector response. Some important classes of photon detectors are listed below.

- *Photoconductive*. The incoming light produces free electrons which can carry electrical current so that the electrical conductivity of the detector material changes as a function of the intensity of the incident light. Photoconductive detectors are fabricated from semiconductor materials such as silicon.

- *Photovoltaic*. Such a detector contains a junction in a semiconductor material between a region where the conductivity is due to electrons and a region where the conductivity is due to holes (a so-called pn junction). A voltage is generated when optical energy strikes the device.

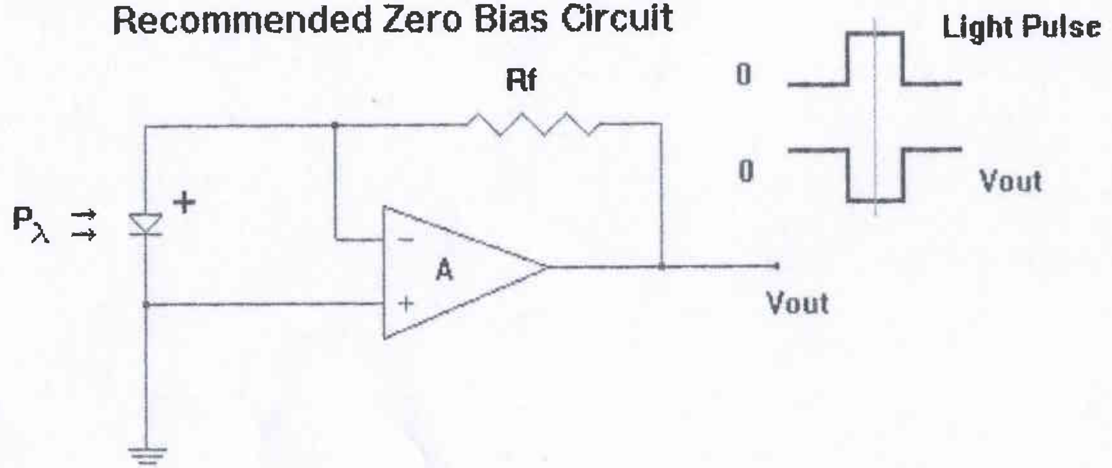
- *Photoemissive*. These detectors are based on the photoelectric effect, in which incident photons release electrons from the surface of the detector material. The free electrons are then collected in an external circuit.

Zero Bias Operation

(b) Zero Bias Operation $V_o=0$ - $R_l \ll R_d$, load line

The generated photocurrent flows through Rl which is fixed. The resultant voltage is therefore linearly dependent on the incident radiation level. One way to achieve sufficiently low load resistance, and an amplified output voltage, is by feeding the photocurrent to an operational amplifier virtual ground as shown below. The circuit has a linear response and has low noise due to the almost complete elimination of leakage current.

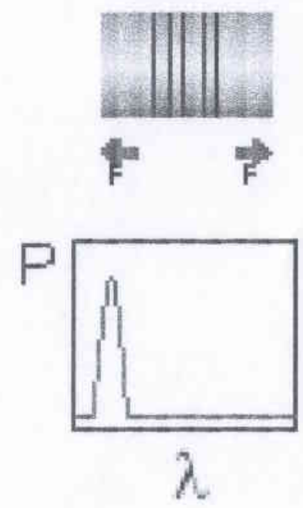
Recommended Zero Bias Circuit



Bragg Grating Sensor

Bragg grating based sensor system is to monitor the shift in wavelength of the returned bragg signal with the changes in the measurand (in this case strain). The bragg wavelength or resonance condition of a grating is given by

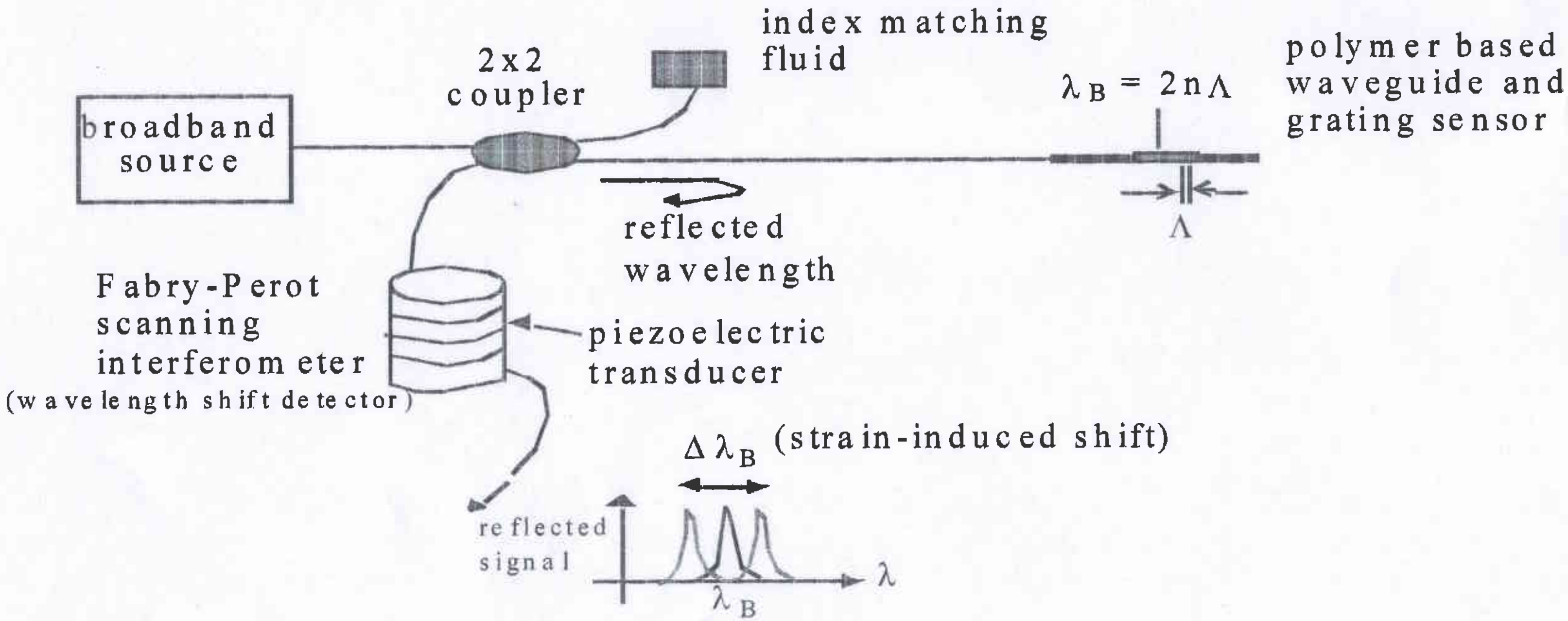
$$\lambda_B = 2n\Lambda$$



Where Λ is the grating pitch and n is the effective index of the core.

Bragg Grating Sensors

The Bragg bandwidth of the reflected by the grating. The bandwidth of the reflected signal depends on several parameters, particularly the grating length. Perturbation of the grating results in a shift in the Bragg wavelength of device which can be detected in either the reflected or transmitted spectrum.



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Bragg Grating Sensor

- **Applications**
- Bragg Gratings have proven attractive in a wide variety of optical fiber applications, such as:
- Narrowband and broadband tunable filters
- Optical fiber mode converters
- Wavelength selective filters, multiplexers, and add/drop Mach-Zehnders
- Dispersion compensation in long-distance telecommunication networks
- Gain equalization and improved pump efficiency in erbium-doped fiber amplifiers
- Spectrum analyzers
- Specialized narrowband lasers
- Optical strain gauges in bridges, building structures, elevators, reactors, composites, mines and smart structures