PH - 301

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END - SEMESTER EVALUATION

PART – II

Que-1:- LCD's contain crystals that are in liquid state, applying voltage to each pixel makes the crystal twist by a variable angle, depending upon voltage or pulse duration. Unlike LED's they consist of a polarised filter layer. The polarisation property of light is used in LCD to create a clear and brighter image by switching its color pixels.

We know that if we use polarized light source and wear polarised glasses, we can see image. Now, each crystal inside each pixel, when rotated by a variable angle, will make the polarised light source rotate but our bare eyes still would not see any image until we use polarised glasses. This is where the liquid intensity coming from the LCD display would change. In technical terms at the back of the screen, there is a bright light that shines out towards the viewer. In front of this are millions of pixels containing sub-pixels of RGB. Thus without this polarized layer light created at the back screen won't be visible to those pixels.

So, to overcome the wearing of polarized glasses, the LCD display contains 2 layers of polarizers, one before the LCD and one after it. The first, on the light source side allowed to present a uniform polarized light source to each pixel.

The second on the viewing side, absorbs a variable percentage of light depending upon the angle of each liquid crystal pixel.

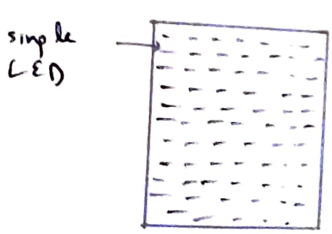
So our eyes will finally receive the image, when it is effectively polarized by the polarizer.

LED.

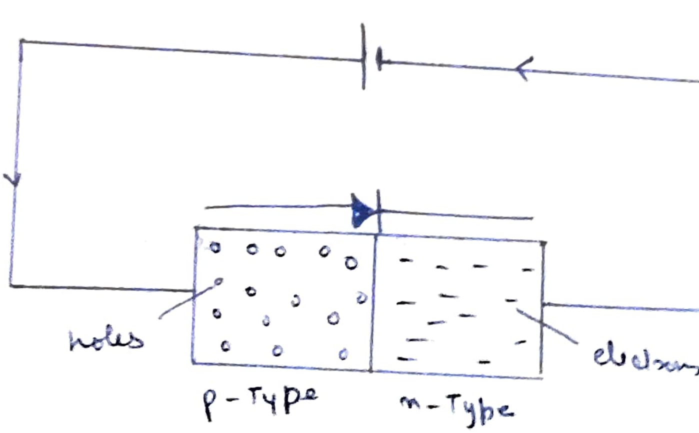
Light Emitting Diodes are used for LED Displays. LED Display is a flat panel display composed of millions of LED's to display image. LED displays can control how the layer transmits light that flows from TV's backlight.

LED TV use advanced form of backlighting and use it to generate on screen imagery.

LED's are highly energy efficient and have better image quality. They also glow during ~~curre~~ exposure to electric current, current flows between LED's anodes and cathodes.



LED Display



Forward Biased LED

Resolution Changes in Different Versions of TV

Resolution on a TV means the number of pixels that are used to create the images, so that no. of pixels changes the resolution.
CRT screens had 480p resolution, meaning that 480 pixels in vertical direction. Similarly HD Screens have 720p resolution; full HD, 2K, 4K, 8K have even higher resolution.

→ 1950's → TV signal transmission with vaccum tube technology was used.

1996 → 1280 X 720 pixels (HD) was introduced.

2000's → 1 Full High Defination Television (HDTV) format with resolutions 1920 X 1080 pixels was used.

Doubling Resolution → 3840 x 2160 pixels (4K) and adding high dynamic range (HDR) took place.

New Generation → 7680 X 4920 pixels (8K) + HDR has been introduced now.

Que 2:

Difference Between Optical and Electron Microscope

1. An optical Microscope uses photons whereas the Electron Microscope uses electrons to enlarge a projected image

2. Electrons have a wavelength in nature that is much smaller than a photon. The result is that electron Microscopes are capable of achieving unprecedented magnification up to one million times. This is much more than the limited magnifying power of an optical ~~instrument~~ microscope of only a thousand times the maximum magnifying power

3. Optical model use a simple lens whereas electron microscope use an electrostatic or electromagnetic lens.

4. Optical models are cheaper and easier to maintain than the electron microscope and they are ideal for general inspection purposes but electron microscope can provide images with more depth.

5. Overall, an electron microscope deliver a more detailed image compared to optical microscope, but it provides only a black/white image which later is reconstructed using A.I. to make it coloured.

6. optical microscopy is an ideal method for general inspection purposes, but electron microscope can provide the user with incredibly detailed ~~teop~~ topographical and compositional information.

7. Only dead speimans without any movement can be visualised under ~~[illegible]~~ electron microscope

LIMITATIONS OF OPTICAL

The resolution of the optical microscope cannot be less than half of the wavelength of visible light which is 0.4 - 0.7 Åμm. When we see green light (0.5 Åμm). the objects that are at most, about 0.2 Åμm. Below, this point, an optical microscope is not useful, since shorter wavelengths than 400 nm are required.

Compared to optical microscopes, electron microscopes have a great advantage of resolution and therefore electron microscope is capable of higher magnification (upto 2 million times) whereas in optical microscope the magnification is only upto 1000-2000 times.

Also, optical microscopes have lower contract power and the image is not very detailed.

All these limitations are overcomed by electron microscope by the smaller wavelength nature of electron over photon.

MATHEMATICAL EXPRESSIONS

(1) ELECTRON MICROSCOPE

We know ;

$h = 6.6 \times 10^{-27}$

$m_e = 9.1 \times 10^{-28}$ kg

$e = 4.8 \times 10^{-10}$

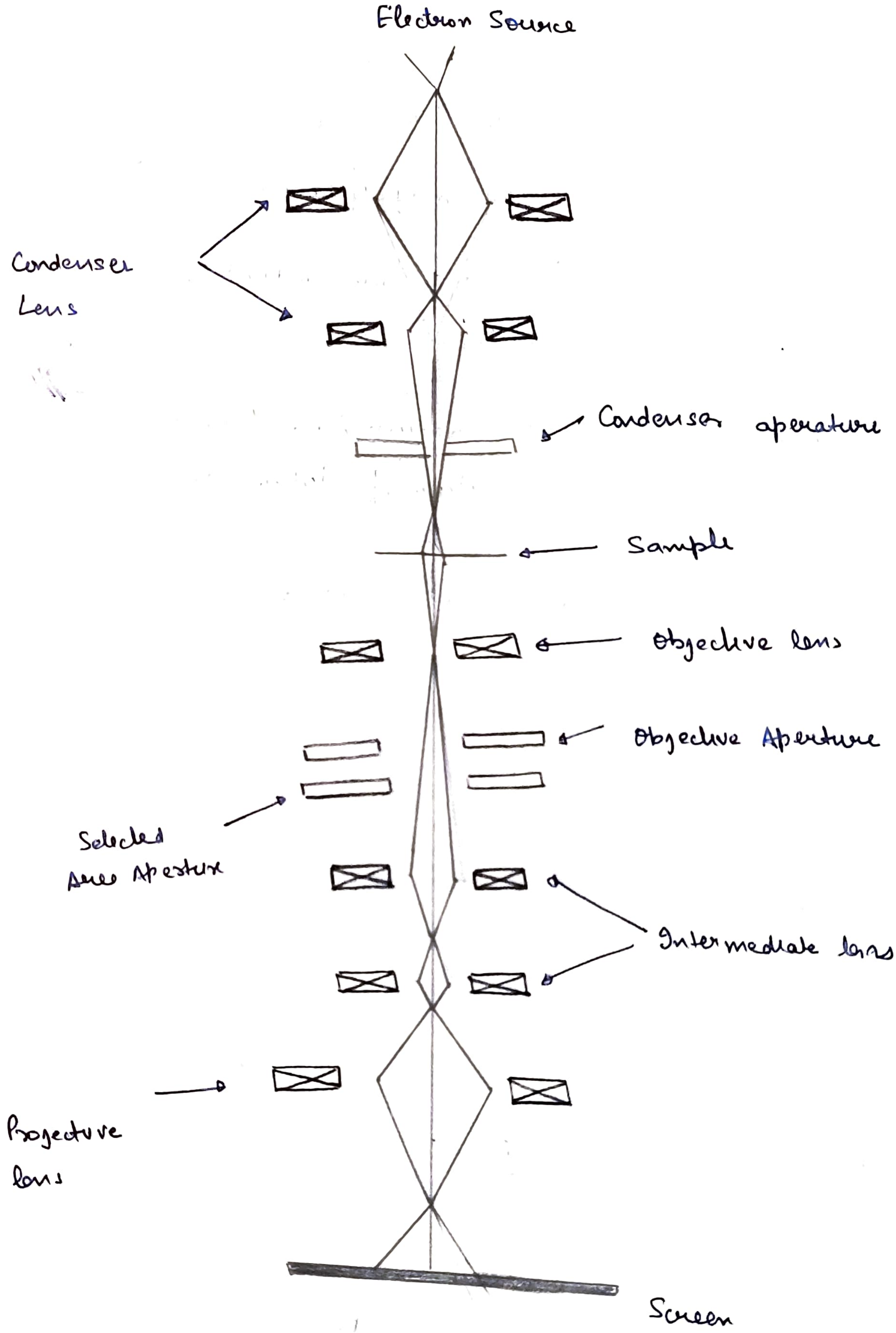
$$\lambda = \sqrt{\frac{h^2}{2meV}} = \frac{12.2\,\text{Å}}{\sqrt{V}}$$

$n = 1$

α is very small $\approx 10^{-2}$ rad.

$$\text{Airy Radius} = \frac{0.61\,\lambda}{n \sin\alpha} = \frac{0.61 \times 12.2}{n \sin\alpha \sqrt{V}}$$

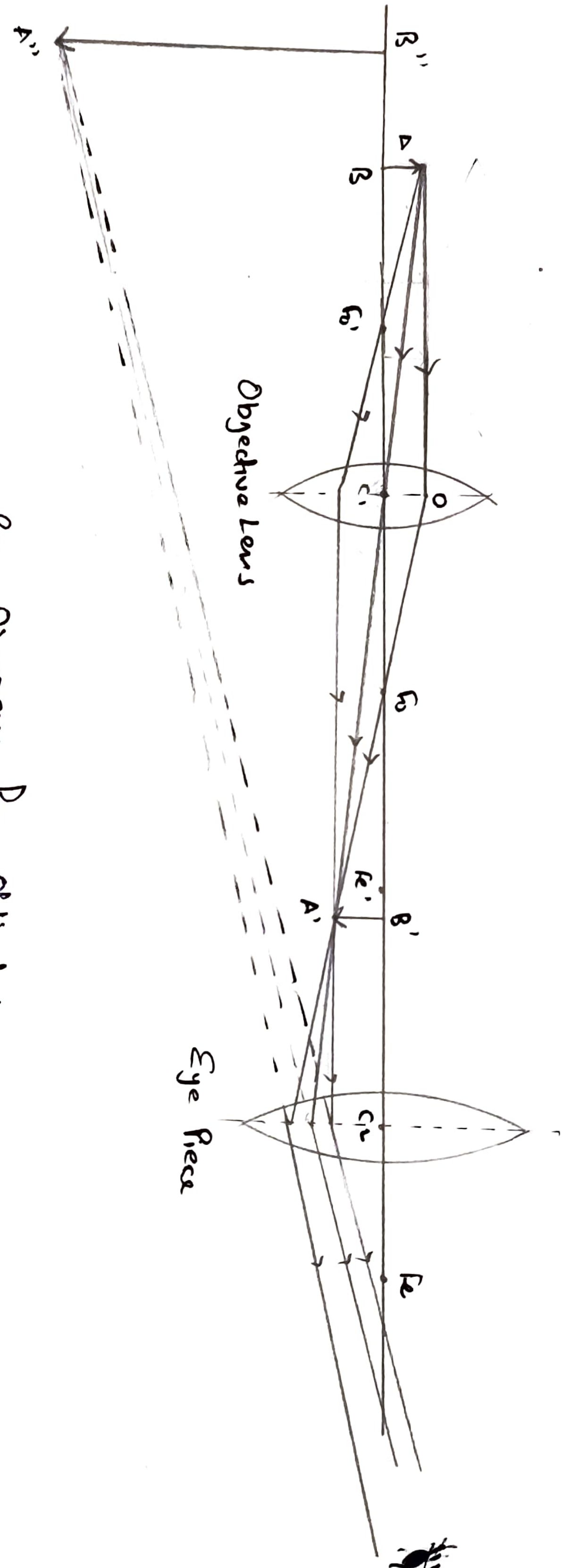
$$r_{airy} = \frac{7.5}{2\sqrt{V}}$$



Electron Microscope.

(2)

OPTICAL MICROSCOPE



Ray Diagram for Optical Microscope.

$$m_o = \frac{-v_i}{v_o}$$

$$m_e = -\frac{v_i'}{v_o'}$$

$$\boxed{m = m_o m_e = \frac{v_i v_i'}{v_o v_o'}}$$

Que 3:-

CCD

Charge-Coupled device is a device that is used in digital Photography that converts an optical image into an electrical signal. They can detect faint amount of lights and are capable of producing high resolution image. Theoretically, CCD's produce Linear - accurate images transmitting the values in a 1:1 ratio. The charge packets are limited to the speed of at which they can be transferred and is majorly responsible for slow speed of CCD. However it is still faster than thermal imager.

Working of CCD

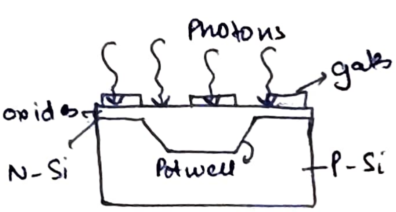
1. The CCD is divided into a large number of light sensitive small areas which we call pixels due to which the CCD is a very sensitive photon detector. A photon of light which falls upon this area can be converted into electrons which is called the Photoelectric effect.

2. Charge is collected as clouds of electrons under biased electrodes during integration of the image.

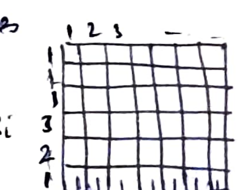
3. Now, along with the bottom of CCD array, one row of charge is transferred to a read out register.

4. Then a differential voltage is applied across the gates and after that the coloumns are read sequentially.

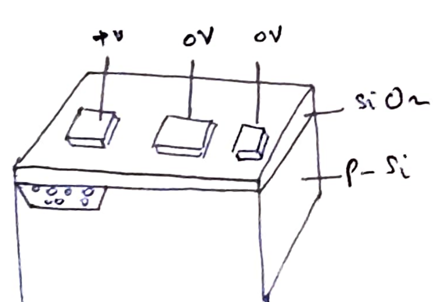
5. Lastly the individual charge pockets are converted to an output voltage in digitized form.



MOS capacitor light sensitive device



Pixels are arranged on a regular grid

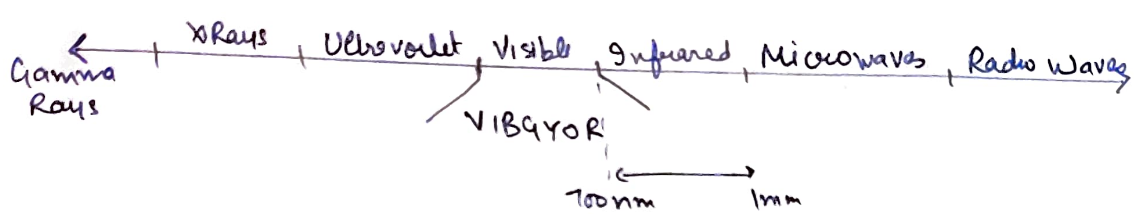


Charge collection By Different Voltage

Thermal Imager

It is a device that creates an image using Infrared radiations. Thermal Imager works well in all conditions. The higher the object temperature, the more the Infrared rays are emitted. It also works fine in total darkness. It uses the concept of Black Body Radiation to form the image. Its pixel response time is in the range of tons of milliseconds.

Working of Thermal Imager



Shorter Wavelength
Higher Frequency
Higher Energy

→ Longer wavelength
Lower Frequency
Lower Energy

1. By recognising the infrared radiation emitted by the object it captures the image. All objects with temperature above 0K emits radiation.

2. The hotter an object is the more the IR Radiation it produces and more bright is the image formed.

3. Most of lenses for thermal cameras have antireflective coating to avoid high fresnal reflection. This makes them very costly as well.

4. Pixel time is fairly slow, at the range of tens of ms.

5. For use in temperature measurements brightness part of image are automatically colored, intermediate temperature red and yellow and dimmest parts are black

6. Their resolutions is considerably lower that that of optics cameras mostly only 160 ×120 or 320 ×240 pixels, although more expensive cameras can achieve a resolution of 1280 ×1024 pixels.

CCD's excels in application where the readout time is less important and readout follows a long integration time.

⇒ Can CCD Camera Be Used As Thermal Imager:

Yes, CCD Camera Can be Used as a Thermal Imager but under suitable changes:

A sufficiently cooled CCD has particularly no dark current and no luminescence. By employing different silicon thickness, backside illumination and AR coatings and work without ~~filters~~ filters the CCD can work in IR Region. which can be seen from ~~the~~ by the spectral range for CCD cameras.

Applications of CCD.

1. It is used in surveillance, hand held and desktop, computer video cameras and document scanner.
2. It is used in optical Microscope.
3. Used in Astronomy space

Applications of Thermal Imager

1. Electrical Wiring Maintaince
2. Checking 3-Phase Equipment
3. First responders
4. Security.
5. Animal Health
6. Mechanical Installations
7. Gas Detection
8. Border Control Forces & Military
9. Firefighting

Que 4:-

Storage Capacities:

CD → 650 mb

DVD → 4.7 GB

Blue Ray Disc → 25 GB

Dual-Layer Blue-Ray — 50 GB

Reasons For Storage Capacity.

1) CD :- In past times, the CD ROM was made as a techinal standard for certain wavelength and data density engineered as a system. Therefore the storage was fixed as a standard so that incompatibility can be avoided amongst different users. It uses a wavelength of 780 nm.

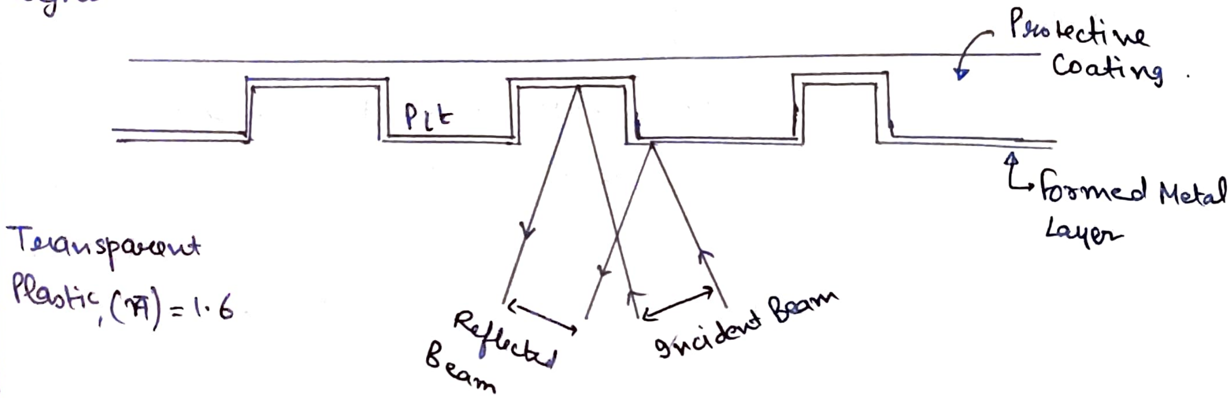
2) DVD :- A DVD can store upto 30 times more info than a CD due to smaller track separation, pit depth and minimum pit length. DVD uses shorter wavelength (650 nm) which helps increasing storage capacity.

3) Blue Ray & Dual layer : They uses a much smaller track pitch and wavelength to acheive such a large capacity. In dual layer the data is stored in multiple layers which double folds the capacity.

	Track Pitch	Wavelength
CD	1600 nm	780 nm
DVD	740 nm	650 nm
Blue Ray	320 nm	405 nm

Reading a CD :

- As disk rotates, laser reflects off sequence of bumps and lower areas into a photo detector.
- Photo detector converts fluctuating reflected light intensity into an electrical string of zeros and ones.
- Pit depth is made equal to one-quarter of wavelength of light.



- When the laser beam (read) hits a rising or falling bump edge part of the beam reflects from top of bump and part from lower adjacent area. This ensure destructive interference and very low intensity when reflected beam combine at the detector.

Bump edges are used as ones.

Flat bumps tops and intervening flat plains are read as zeros.

Writing On a CD

The surface of the CD is made of a Polycarbonate layer with molded spiral tracks on top. The data is stored on the CD as a series of minute grooves known as pits and lands.

The burning process by which we write on a CD involves a write laser which creates a pattern of pits and lands on CD. These Pits and Lands represent 0's and 1's respectively and hence data is encoded on the surface

The storage capacity can be further enhanced by using smaller track separation, pit depth and minimum pit length.

Also the wavelengths that are used can be even smaller to read and interpret the data stored.

Also, multilayer storing can also be further thougth upon. and to improve it better techniques ~~should~~ can be developed to interleave data on different layers.

Basically; wavelength ~~should b~~. can be more small and track pitch can be reduced even further to enhance the storage capacity more.

Que 5.

Considering a transparent object with amplitude transmittance

ie $t(x,y) = \exp[i\phi(x,y)]$

Expanding $\exp[i\phi(xy)] \rightarrow$

$$e^{i\phi(x,y)} = 1 + i\phi(x,y) - \frac{1}{2}\phi^2(x,y) - \frac{1}{6}i\phi^3(x,y) + \frac{1}{24}\phi^4(x,y) + \dots$$

For simplicity, we will assume that the object has a magnitude of unity and finite extent of entrance-exit pupils are neglected.

Now, there is a necessary condition to achieve linearity between phase shift and intesity which is:
The variable part of the object-induced ~~part~~ phase-shift $\Delta\phi(x,y)$ should be small compared to the 2π radians. Applying approximation to amplitude transmittance.

$$t(x,y) = e^{i\phi_0} e^{i\Delta\phi} \approx e^{i\phi_0}[1 + i\Delta\phi]$$

$$I = |1 + i\Delta\phi(x,y)|^2 \approx 1$$

Phase changing plate consists of a glass substrate on which a small transparent di-electric dot is deposited. Dot is centered on optical axis in focal plane and has a thickness and index of refraction such that it change phase of focused light by either $\pi/2$ radians or $\frac{3\pi}{2}$ radians relative to phase retardation of diffracted light.

\# If phase retardation is by $\pi/2$ radians. Intensity in image plane becomes.

$$I = |\exp(i(\pi/2)) + i\pi\phi(x,y)|^2$$

$$= |i\{1 + \Delta\phi(x,y)\}|^2 = 1 + 2\Delta\phi(x,y)$$

Image intensity has become linearly related to variations of phase shift $\Delta\phi(x,y)$

This situation is referred to as a <u>+ve Phase Contrast</u>

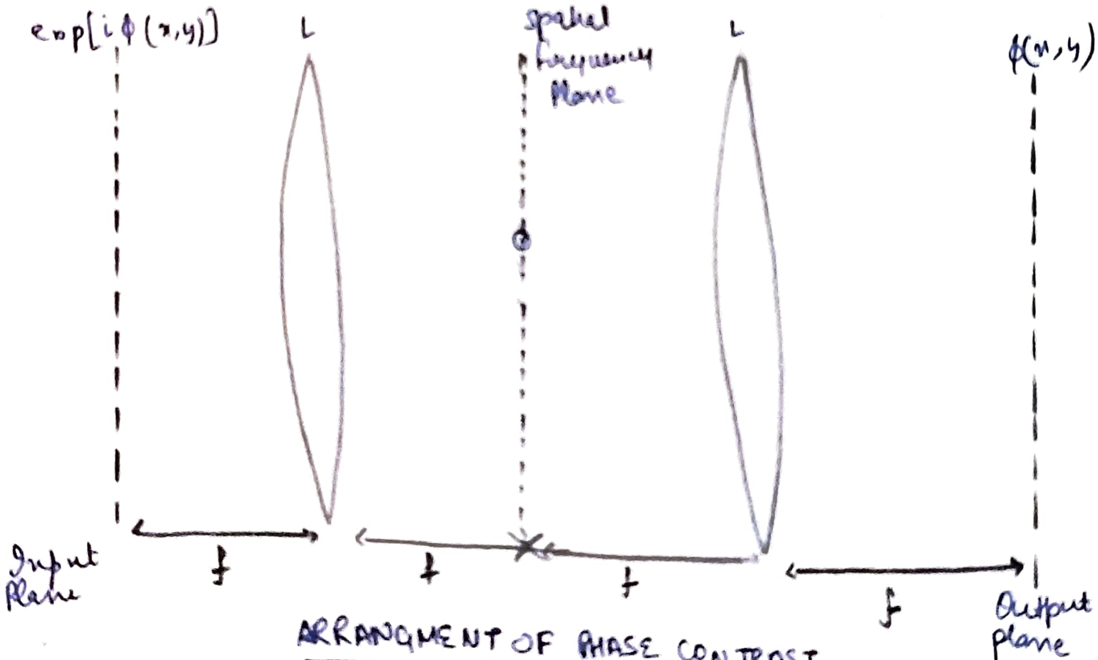
\# If the phase retardation is by $\frac{3\pi}{2}$ radians, the intensity of the image plane becomes.

$$I \approx |\exp[i(\tfrac{3\pi}{2})] - i\Delta\phi(x,y)|^2$$

$$= |-i\{1-\Delta\phi(x,y)\}|^2$$

$$\approx 1 - 2\Delta\phi(x,y)$$

This situation is referred to as a <u>-ve Phase Contrast</u>



<u>ARRANGMENT OF PHASE CONTRAST</u>

The Principle behind Phase Contrast Microscope is to convert undistinguishable phase change into distinguishable phase change in terms of variations of contrast with the help of two adaptions annular diaphragm and annular phase plate

Que 6:- Focal length of the lens (f) = 50 cm

Altitude of the flying aircraft (The object distance) (u) = 2000 m

Size of film in the camera = $(18 \times 18)\ cm^2$

Now;

Aerial magnification = $\frac{\text{Area of the image}}{\text{Area of the object}} = m^2$

where m → linear magnification.

Linear Magnification (m) = $\frac{f}{f+u} = \frac{0.5}{0.5-2000} = \frac{-1}{3999}$

$\approx \frac{-1}{4000}$

Area of the object = $\frac{\text{Area of the image}}{m^2}$ [Image size = size of camera film].

$= 18 \times 18 \times \frac{1}{\left(\frac{-1}{3999}\right)^2}$

$= 18 \times 18 \times 3999 \times 3999$

$= (71,982 \times 71,982)\ cm^2$

So, Area of the ground that can be photographed by the camera at any one time =

$\boxed{(71,982 \times 71,982)\ cm^2}$

Que 7: Grassman's Laws of Linearity and Additivity:

1. Any color can be matched by a suitable mixture of any three stimuli provided that none of these three stimuli can be matched by the combination of other two

2. If two colours are matched in turn by mixtures of three stimuli, then ~~two~~ sum of two colours will be matched by the sum of two mixtures.

Also, Colour Matching persist at all Luminance (it fails at low level when rods take over the cone cells)

Color Matching Equation:

$$C\cdot(C) \equiv R\cdot(R) + G\cdot(G) + B\cdot(B)$$

such that $C = R + G + B$.

It means that a color 'C' can be matched by R units of Red, G units of Green and B units of Blue.

Now;

From this we can infer

$$C_A(C) = C_B(C) + C_C(C)$$

$$= (R_B + R_C)R + (G_B + G_C)G + (B_B + B_C)B$$

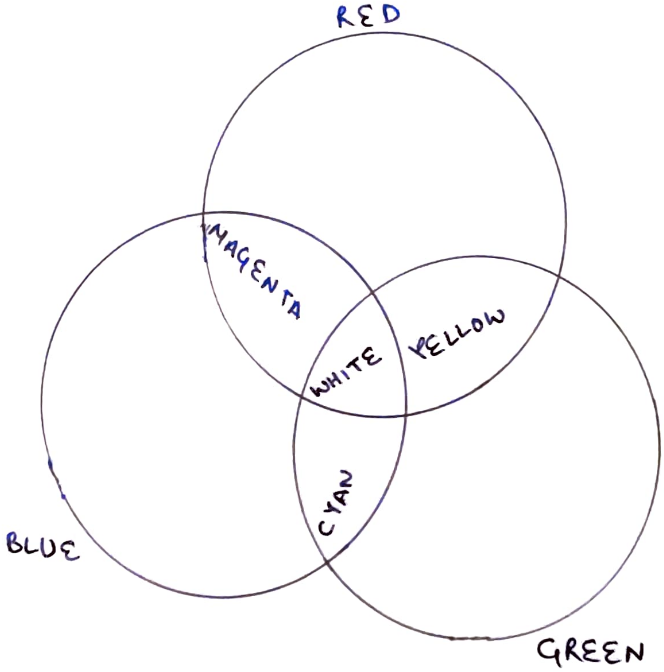
Unit Equation of Color Theory

$$1\cdot(C) = r\cdot(R) + g\cdot(G) + b\cdot(B)$$

$$r = \frac{R}{R+G+B} \qquad g = \frac{G}{R+G+B} \qquad b = \frac{B}{R+G+B}$$

Hence; $r + g + b = 1$; $r, g, b \rightarrow$ chromaticity Co-ordinates

Additive Color Mixing



eg

1R = Red

1B = Blue

1G = Green

1G + 1B = Cyan

1R + 1B = Magenta

1R + 1G = Yellow

1R + 1G + 1B = White