SAP ID - 60004200132
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Div - J1

DATE:

Engineering Physics

Assignment in Lieu of Term Test 1

1) Fraunhofer diffraction pattern is obtained with a slit of width 0.28 mm and He-Ne laser as the light source. Determine the angles at which the central maxima, first secondary maxima and first minima are formed?

Ans $a = 0.28\,mm = 0.28 \times 10^{-3}\,m.$

$\lambda = 6328\,Å$ (visible Region - red colour)

Formula: i) $a\sin\theta = \pm (n+\frac{1}{2})\lambda$

ii) $a\sin\theta = n\lambda$

Solution:

i) For central maxima, $\boxed{\theta = 0}$

ii) For first secondary maxima put $n=1$ in $(n+\frac{1}{2})\lambda = a\sin\theta$

$\therefore \frac{3}{2}\lambda = a\sin\theta$

$\frac{3 \times 6328 \times 10^{-10}}{2} = \sin\theta \times 0.28 \times 10^{-3}$

$\therefore \sin\theta = (33900 \times 10^{-7})$

$\therefore \boxed{\theta = 0.19423^{\circ}}$

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iii) For first order minima, substitute $n=1$ in
$a\sin\theta = n\lambda$

$$\therefore \theta = \sin^{-1}\left[\frac{1\times 6328\times10^{-10}}{0.28\times10^{-3}}\right]$$

$$\theta = \sin^{-1}(22600\times10^{-7})$$

$$\therefore \boxed{\theta = 0.1295^{\circ}}$$

2) A monochromatic light of wavelength 5860 Å is incident normally on a 2 cm wide grating. The first order spectrum is produced at an angle of 20° with respect to the normal. Determine the total number of lines on the grating and the grating element.

Ans Given: $\lambda = 5860\times10^{-8}$ cm ; $n=1$
$\theta = 20^{\circ}$
$a = 2cm$ = width of grating.

Formula: 1) $a+b = \frac{1}{\text{no. of lines}}$ = grating element

2) $(a+b)\sin\theta = n\lambda$

Solution: $n\lambda = (a+b)\sin\theta$

$$\therefore a+b = \frac{1\times5860\times10^{-8}}{0.34202}$$

$$\therefore a+b = 1.7133\times10^{-4}\ cm$$

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Number of lines /cm $= \frac{1}{a+b} = \frac{1}{1.7133 \times 10^{-4}}$ $= 0.58367 \times 10^{4}$

$= 5836.7$

∴ Total number of lines = number of lines /cm

$= 5836.7 \times 2$

$= 11673$

∴ Total number of lines are 11673 and the grating element (a+b) is 1.7133×10^{-4} cm

3> In an optical fiber, the cladding refractive index is 1.5 and the fractional index change is 0.0625. Calculate the cut off parameter and the number of modes possible if the radius of the core is 50 µm and vacuum wavelength is 10 nm. Also mention the type of the optical fibre based on the ~~numerical~~ number of modes.

Ans. Given: Fractional index = 0.0625

$\mu_2 = 1.5$

$a = 50 \times 10^{-6}$ m

$\lambda = 10 \times 10^{-9} = 10^{-8}$ m

Formula: 1) $\Delta = \frac{\mu_1 - \mu_2}{\mu_1}$

2) $NA = \sqrt{\mu_1^2 - \mu_2^2}$

3) cut off Parameter $= \frac{\pi d (NA)}{\lambda}$

4) $d = 2a$

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Solution :

$$\Delta = \frac{\mu_1 - \mu_2}{\mu_1} = 0.0625$$

$$= 0.0625 = \frac{\mu_1 - 1.5}{\mu_1}$$

$$\therefore \mu_1 = 1.6$$

$$NA = \mu_1 \sqrt{2\Delta}$$
$$= 1.6\sqrt{2 \times 0.0625}$$
$$= 0.56568$$

Cut off parameter (v-number) $= \frac{\pi d (NA)}{\lambda}$

$$= \frac{\pi (2a)(NA)}{\lambda}$$

$$\therefore V = \frac{3.14 \times 2 \times 50 \times 10^{-6} \times 0.56568}{10^{-8}}$$

$$= 177.736 \times 10^{2}$$

$$\therefore V = 17773.665$$

Number of modes possible $= \frac{V^2}{2}$

$$= \frac{1}{2}(17773.6)^2$$

$$= 157950428.5$$

$\because V > 2.405$ it is a MMF i.e a multimode fibre as it can support many modes.

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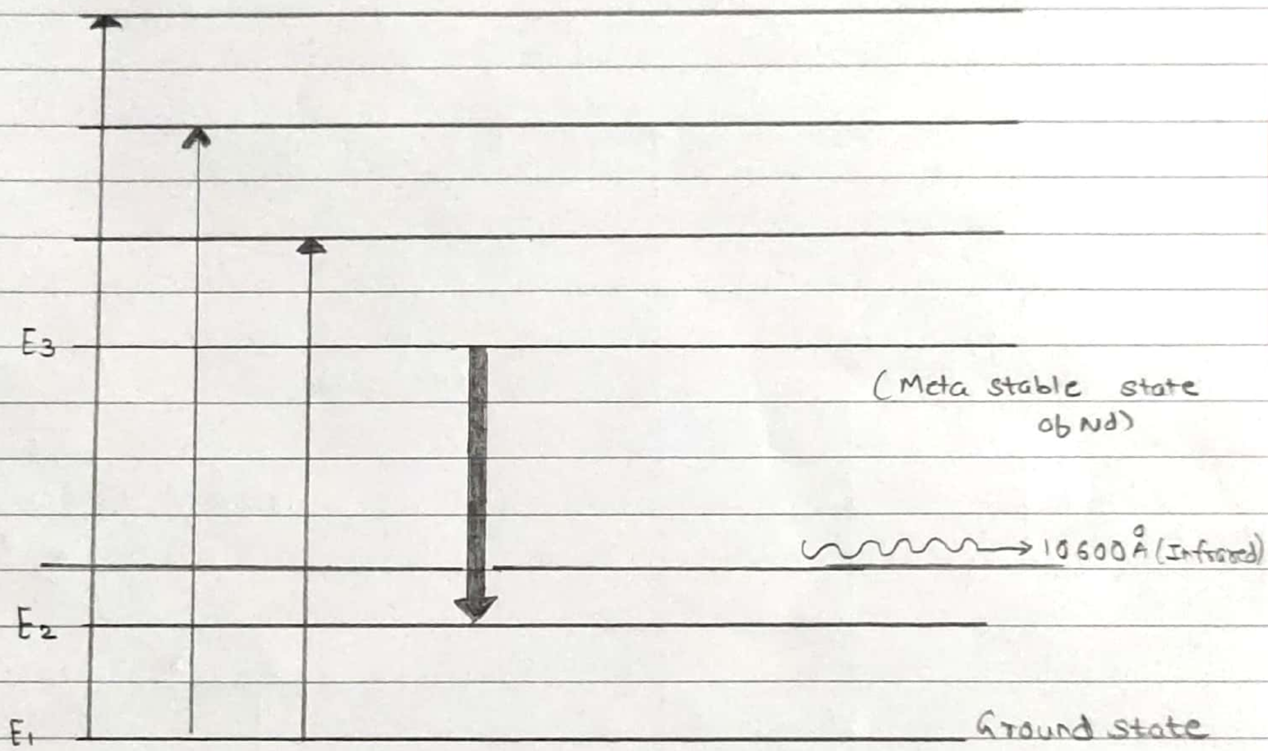
4) Draw neat and labelled energy level diagram of Nd:YAG laser.

Ans



Energy levels of Nd along with YAG

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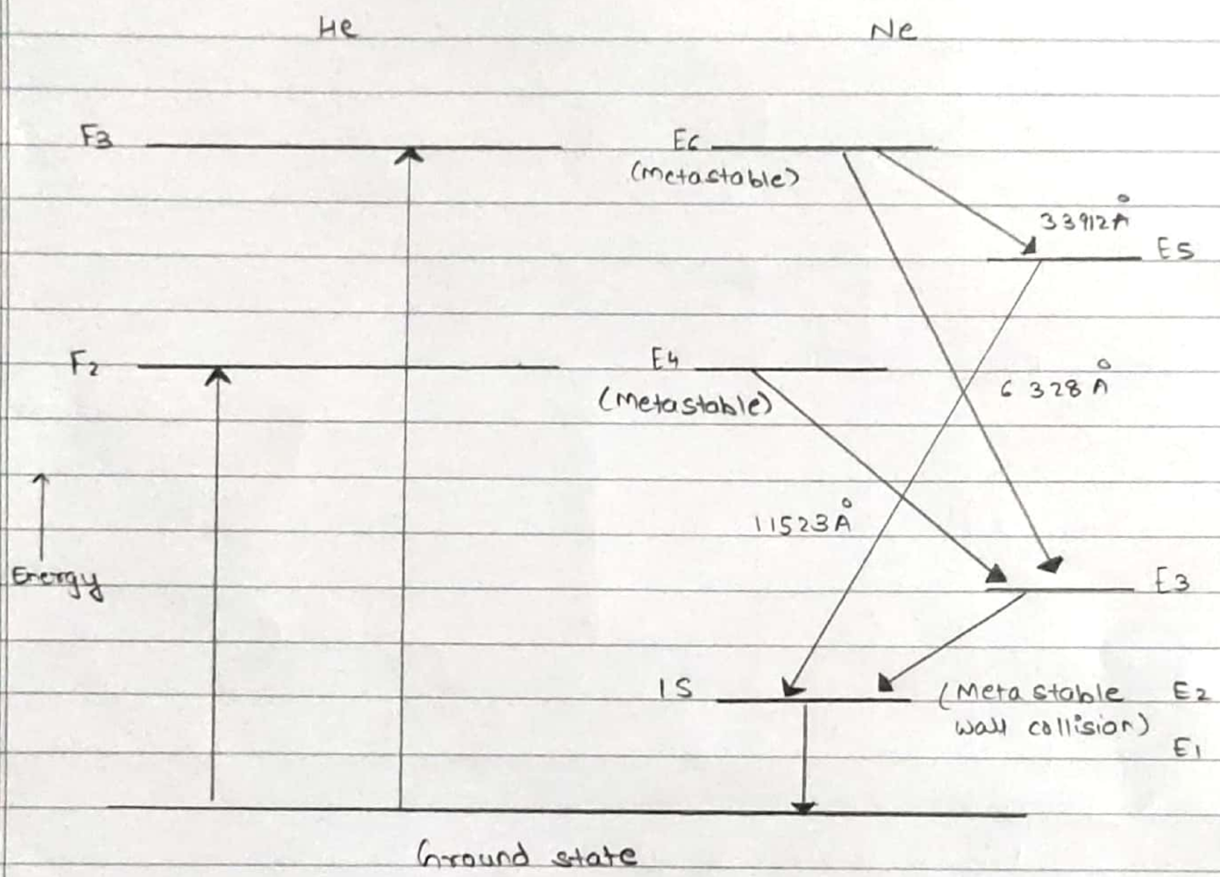
5) Draw neat and labelled energy level diagram of He-Ne laser.

Ans



Energy level diagram of He-Ne

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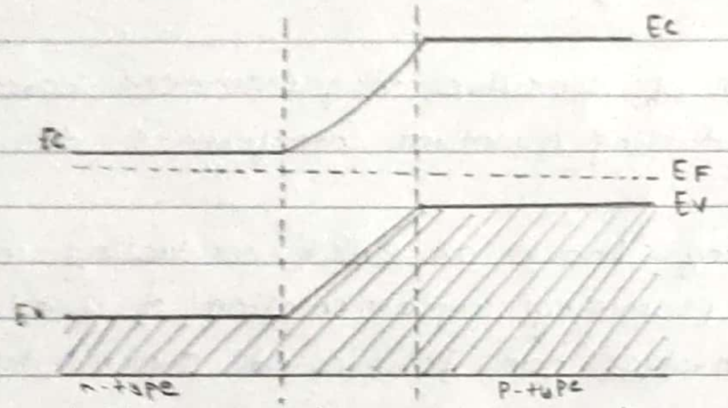
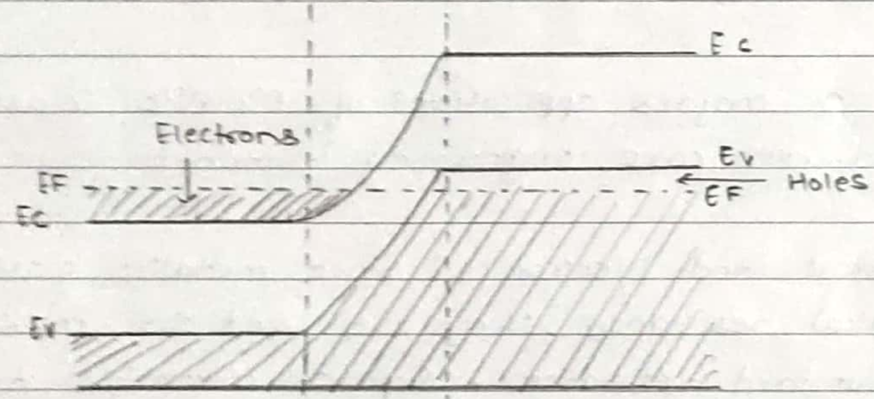
5) Draw neat and labelled energy level diagram of semiconductor laser.

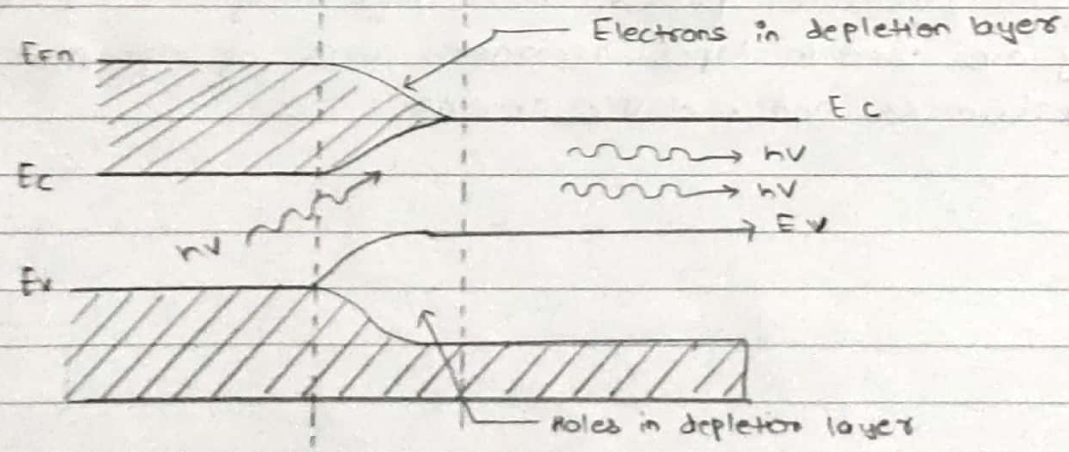
Ans



(a) Lightly doped p-n junction (unbiased)



(b) Heavily doped p-n junction (unbiased)



(c) A forward biased and heavily doped p-n junction above threshold value.

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7) State any 2 major applications of Superconductors in connection to your core engineering branch.

Ans i) The production of sensitive magnetometers based on SQUID's (Superconducting quantum interference device)

ii) Quantum computing known as super conducting quantum computing. It is promising implementation of quantum information technology that involves non-fabricated superconducting electrodes.

8) State any 2 majors applications of Metallic Glasses in connection to your core engineering branch.

Ans i) In Electrical and Electronics: Since metallic glasses have high electrical resistance, they are used to make accurate standard resistance, computer memories and magnetic resistance sensors.

ii) Since, metallic glasses have soft magnetic properties, they are used in tapes recorder, cores of high-power transformers and metallic shields.

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9) State any 2 major applications of Shape memory Alloys in connection to your core engineering branch.

Ans i) Robotics : There have been studies on using these materials in robotics as they make it positive to create very lightweight robots.

2) The second application was an autofocus (AF) for a smart phone There are currently many companies working on optical image stabilization movies made by wires from SMA's.

10) State any 2 major applications of non-linear optics in connection to your core engineering branch.

Ans (i) Frequency Powering : One of most commonly used frequency-mixing process is Frequency Powering or second - harmonic generation.

(2) Optical-phase conjugation : Using non-linear optical ~~isomer~~ process to exactly reverse the propogation direction and phase variation ~~and technique~~ of beam of ~~liquid~~light. The reversed beam is called conjugate beam and technique is known as optical phase conjugation. A device producing phase conjugation effect is known as phase conjugate mirror.