M.Sc. Examination, 2019

Semester - IV

Physics

Course: MPC-463 (Special Paper)

(Quantum Electronics-III)

Time: Three Hours **Full Marks: 40**

Questions are of value as indicated in the margin.

Answer ***any four*** questions

1. What you mean by internal second harmonic generation? Obtain the expression for the optimum coupling during an internal second harmonic generation. In an internal second harmonic generation of $Nd^{3+}:YAG$ laser of $\lambda = 1.06\times10^{-6}m$ with internal loss $L_i = 2\times10^{-2}$, stauration power $2W$, nonlinar constant $d = 1.1\times10^{-22}MKS$and $n = 1.5$. Assuming the beam diameter as $70\,\mu m$, and phase matching condition, calculate the optimum length of the crystal. 1+5+4

2. By using a self-consistent analysis, obtain the oscillation condition for a Parametric Oscillator. 10

3. How the parametric interaction and hence the parametric oscillator is taken care quantum mechanically? What you mean by noise terms? 9+1

4. Define Squeezing operator $S(\zeta)$. Establish the following relations

$$S^\dagger(\zeta)aS(\zeta) = a\cosh r - a^\dagger \exp(i\theta)\sinh r$$

where $\zeta = r\exp(i\theta)$. Why the eigenstate of the squeezing operator is termed as two-photon coherent state? Assuming $\theta = 0$ and the initial squeezed vacuum state $|\zeta>= S(\zeta)|0>$, show that

$$\begin{aligned}(\Delta X_1)^2 &= \tfrac{1}{4}\exp(-2r)\\ (\Delta X_2)^2 &= \tfrac{1}{4}\exp(2r)\end{aligned}$$

where X_1 and X_2 are the usual dimensionless quadrature operators. 1+5+1+3

5. What a squeezed vacuum state is? Show that the squeezed vacuum state can be expressed in terms of the even photon number state. Obtain the photon number distribution in squeezed vacuum state for even and odd number states. 1+6+3

6. Establish that the Stimulated Raman scattering indeed useful for getting the Raman Laser. Calculate the Raman gain in CS_2 molecule with following paramaters, $T = 300^0K$, $\nu_l = 4.32\times10^{14}Hz, \nu_v = 656\,cm^{-1}$, $\nu_s = 4.123\times10^{14}Hz$. 6+4

7. Solve the nonlinear Schrodinger equation $-\frac{1}{2}\sigma\mu\frac{\partial^2 E_\omega}{\partial\tau^2} - \lambda|E_\omega|^2E_\omega = i\frac{\partial E_\omega}{\partial\xi}$ (Symbols are of usual meanings). Put your Comments on the nature of the solution. 9+1
