PG/IIIS/CEM-303/18

M.Sc. 3rd Semester Examination, 2018

CHEMISTRY

PAPER – CEM-303

Full Marks : 40

Time : 2 hours

The figures in the right-hand margin indicate marks

1. Answer any *four* questions : 2 × 4

   (*a*) What are chemical LASERS ?

   (*b*) What are optical cavities in LASERS ?

   (*c*) What do you mean by coherence in LASER ?

   (*d*) What do you mean by the term "Stokes shift" ?

   (*e*) What is Stern-Volmer quenching ?

   (*f*) The benzene radical anion has $g = 2{\cdot}0025$. At what field should you search for resonance in a spectrometer operating at 29·453 GHz ?

(*g*) Write the name and structure of a compound which is use as standard compound for ESR spectroscopic study. Why this compound is use as standard compound ?

(*h*) What do you mean by "X-band frequency" and "Q-band frequency" in ESR spectroscopy ? What are the advantages and limitations in using "Q-band frequency" ?

2. Answer any *four* questions : 4 × 4

(*a*) Explain the construction and function of a He-Ne LASER. 4

(*b*) "LASERS are non-mechanical knives" – criticize or justify. What kind of dyes are used in modelocking ? 2 + 2

(*c*) Compare and contrast active and passive modelocking. 4

(*d*) Predict the ESR spectrum of the following radical/anion : 2 + 2

$$\dot{N}H_2/C_6H_6^-.$$

(*e*) Briefly explain as how you can determine the binding constant of macromolecule with a drug using Benesi-Hildebrand equation. 4

(*f*) Showing all possible transitions, discuss the ESR spectrum of $[CD_3]^{\bullet}$ radical. 4

(*g*) The EPR spectrum of

$$[(NH_3)_5\,Co - O_2 - Co\,(NH_3)_5]^{5+}$$

shows fifteen lines. Derive the structural information of this complex ion from this data. 4

(*h*) Explain the ESR spectrum of radical anion of pyrazine. 4

3. Answer any *two* questions : 8 × 2

(*a*) What is an optical resonator in LASER ? Schematically show the energy diagram of a three level LASER. Why in a Ruby LASER a trace amount of Cr^{3+} ion is doped with aluminium ? Why are waveguides essential in IR-LASERS ? 2 + 2 + 2 + 2

(*b*) Show that a two level pumping scheme has no practical significance for lasing. What do you mean by modes in a resonator ? What is the relation between the frequency difference between successive modes for a cavity of length L ? 3 + 3 + 2

(*c*) How does the polarity of a solvent influence the absorption and emission spectra of a solute ? Explain it with iodine as a solute. Why do the phenolic compounds dissociate at lower pH in the excited state while the same is relative higher in the ground state ? 4 + 4

(*d*) (*i*) Using following information predict the pattern of the ESR spectrum of a radical $[XY_2]^{\bullet}$. 4

	Nuclear spin quantum number	Hyperfine coupling constant
X	1	$2a$
Y	1/2	a

(*Continued*)

(*ii*) Comment about the ESR activity of the following metal ions in the octahedral complexes : 2

Cr(III), Cr(IV)

(*iii*) Calculate theoretically possible number of lines in the EPR spectrum of $[V(O)(acac)_2]$. (acac = acetylacetonato). 2
