Reg. No. | | | | | | | | | | |

MANIPAL INSTITUTE OF TECHNOLOGY

MANIPAL

(A constituent unit of MAHE, Manipal)

SEVENTH SEMESTER B.TECH. (INSTRUMENTATION AND CONTROL ENGG.)
END SEMESTER DEGREE EXAMINATIONS, DECEMBER - 2020

SUBJECT: ANALYTICAL AND OPTICAL INSTRUMENTATION [ICE 4101]

23-12-2020

TIME: 3 HOURS MAX. MARKS: 50

Instructions to candidates :*Answer ALL questions and missing data may be suitably assumed.*

1A. What is the range of bandgap (in eV) for a LED to emit green light (538-540 nm)? A ruled grating of 600 lines/mm is placed perpendicular to this light's path. Find the angle for the occurrence of first order maxima.

1B. Define integration time and scans to average of a spectrophotometer. What determines the choice of these parameters? How would you amplify a weak optical signal using these parameters? What happens to the SNR in that case?

1C. Calculate the numerical aperture of an objective lens when in air, water and oil. Assume that the fluids form a cubical interface of dimensions 1.2 mm with the lens. Assume RI of air, water and oil as 1, 1.33 and 1.57. How would you correlate numerical aperture and resolution in micro-imaging systems?

(2+4+4)

2A The NMR Spectrum contains single peaks at shifts of 7.27, 3.07 and 0.57. The empirical formula of the compound is $C_{10}H_{13}Cl$. Deduce the structure of the compound.

2B A first order binding event of time constant 12 seconds is being monitored by a spectrophotometer at 530 nm. The spectrophotometer has a 16 bit ADC, SNR of 250:1 and a dark noise of 22 counts. Assume that the spectrophotometer was near saturation at 530 nm during start of experiment. When the spectrophotometer setting has an integration time of 20 ms and 2 scans to average, at t=100s a count of 1100 with a read noise of 100 counts is observed. Calculate:

a) Range of absorbance at t=100s (for 530 nm)
b) SNR, if 100 scans with an integration time of 20 ms are averaged
c) Draw the absorbance characteristics (w.r.t. time) for the setting in part (b) and for the setting provided in the question. Which is the setting you would prefer and why?

2C Compare and contrast the working principle and applications of Time of flight, Magnetic deflection and Quadrupole Mass spectrometers.

(2+3+5)

3A In two level lasers there is no lasing action and lasing is much easier in four level lasers than three level lasers. Discuss on the statement.

3B With the block diagram of High pressure liquid chromatograph, explain its principle of operation and applications.

3C Discuss on the principle of Holography. How is on axis holography different form off axis holography?

(2+4+4)

4A Calculate the frequency range of a signal as seen by the detector of a Michaelson's interferometer with a mirror moving with a velocity of 0.333 cm/s, for input radiation in the range from 680 nm to 20 μm.

4B With a suitable example, compare the working of solid state laser and gas laser.

4C Write short notes on evanescent wave based ATR and surface plasmon resonance (SPR) with a suitable diagram.

(2+3+5)

5A Why is calorimetry a prominent analytical tool for the detection of SO_2?

5B Discuss different methods for the detection of Nitrogen oxides in environment.

5C With a block diagram, explain the working of infrared gas analysers and how does it differ from thermal analysers?

(2+3+5)

****