KATHMANDU UNIVERSITY
End Semester Examination [C]
December, 2024

Marks Scored:

Level : B.E./B.Tech.
Year : III

Course : INAN 301
Semester : II

Exam Roll No. :

Time: 30 mins.

F. M. : 20

Registration No.:

Date : 24 DEC 2024

SECTION "A"

[20 Q. × 1 = 20 marks]

Choose and mark [X] in the most appropriate option from the given set of choices

1. Which of the following is correct regarding NMR spectroscopy?
   [ ] Low field, high shielding, low frequency
   [ ] Low field, low shielding, high frequency
   [ ] High field, high shielding, high frequency
   [ ] High field, low shielding, low frequency

2. The frequency of vibration of a bond mainly depends upon
   [ ] Force constant of the bond
   [ ] Masses of the atoms involved in bonding
   [ ] Force constant of the bond and masses of the atoms
   [ ] Atomic population

3. $C_6H_5NH_3^+$ under alkaline condition is converted to $C_6H_5NH_2$. Select the correct statement regarding their λ_{max}.
   [ ] $C_6H_5NH_2$ shows longer wavelength than $C_6H_5NH_3^+$
   [ ] $C_6H_5NH_3^+$ shows longer wavelength than $C_6H_5NH_2$
   [ ] Both species show almost equal wavelength
   [ ] $C_6H_5NH_2$ shows absorption but $C_6H_5NH_3^+$ does not

4. Sputtering is associated with
   [ ] UV-visible spectroscopy [ ] IR spectroscopy
   [ ] NMR spectroscopy [ ] Atomic absorption spectroscopy

5. Which of the following hydrogen indicated as I to IV in the following molecule gives triplet signal in NMR spectrum?
   CH_3 (I)-CO-CH_2 (II)-CH (III)-$(OCH_3)_2$ (IV)
   [ ] I [ ] II [ ] III [ ] IV

6. The process of mass spectrometric analysis consists of different steps. Arrange the following steps in serial.
   A) detector, B) vacuum pump, C) recording, D) mass analyzer, E) sample inlet
   [ ] B, E, D, A, C [ ] E, A, B. D, C [ ] E, A, B, C, D [ ] E, B, D, A, C

7. In Mass Spectrometry, which ionization technique is known for producing molecular ions that retain their parent molecule structure intact?
   [ ] Electron Ionization (EI)
   [ ] Chemical Ionization (CI)
   [ ] Matrix-Assisted Laser Desorption Ionization (MALDI)
   [ ] Electrospray Ionization (ESI)

8. In reverse-phase HPLC, the stationary phase is.
[ ] Polar [ ] Non-polar [ ] Neutral [ ] Ionic

9. In thin layer chromatography, the stationary phase is made up of _____ and the mobile phase is made up of _____.
[ ] liquid, liquid [ ] solid, liquid [ ] liquid, gas [ ] solid gas

10. The chemical shift in NMR is equal to ____ ppm.
[ ] $(\sigma_{\text{reference}} - \sigma_{\text{sample}}) \times 10^6$ [ ] $(\sigma_{\text{sample}} - \sigma_{\text{reference}}) \times 10^6$
[ ] $(\sigma_{\text{reference}} + \sigma_{\text{sample}}) \times 10^6$ [ ] $\sigma_{\text{reference}}/\sigma_{\text{sample}}$

Fill in the blanks by most appropriate VALUE or WORD.

11. In a chromatogram of a mixture of species A and B; the void time is 1.0 min, retention time for A and B species is 6.0 min and 11.0 min respectively. The selectivity factor α will be _____.

12. Flameless atomizer in atomic absorption spectroscopy is mainly made from_____.

13. _____is the slope of the calibration curve at the concentration of interest.

14. The life time of excited species for e.g. M* is very short and undergo relaxation by _____ and _____ ways.

15. In GC separation, _____ columns are used when high solvent holding capacity is required.

16. In IR spectroscopy, the possible modes of vibration of ethanol will be _____.

17. Compared to $\pi - \pi^*$ transition, n to π^* transition in UV-Vis spectroscopy, λ_{max} will be_____and energy required will be _____.

18. HPLC guard columns are packed by _____ type.

19. Too small molecules in size exclusion chromatography are eluted with _____ _____.

20. In anion exchange chromatography, the resin must contain _____ charge and the sample in the solution should have _____ charge.

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Semester : II
F. M. : 55

SECTION "B"
[5 Q. × 3 = 15 marks]

Attempt *ANY FIVE* questions.

1. Giving an example of linear and non-linear molecule, show the calculation of the total possible modes of vibration.
2. Show the measurement process of an instrument in block diagram serially. What properties of an analyte fall under electrical domain?
3. What is a gradient elution? Why and how is it performed in HPLC system?
4. What is retardation factor R_f value in thin layer chromatography? What is its significance?
5. Predict the proton magnetic resonance (PMR) spectra of CH_3CH_2OH in low- and high-resolution conditions. Also explain the spectra.
6. What are the major differences between hard and soft ion sources in mass spectrometry?
7. Explain the types of emission spectra in brief.

SECTION "C"
[5 Q. × 5 = 25 marks]

Attempt *ANY FIVE* questions.

8. a. Give a comparative note on group frequency and fingerprint region of IR spectra. [3]
   b. What are the properties of internal reference material in NMR and why is it used? [2]
9. a. Why does increasing the conjugated double bonds increase the λ_{max} in UV-Vis spectroscopy? Differentiate between chromophores and auxochromes. [3]
   b. What are the experimental procedures for running flame photometry? [2]
10. a. Mention the applications of thin layer chromatography (TLC). [3]
    b. Compare HPLC and GC in terms of (i) principle of separation (ii) nature of mobile phase (iii) column material and (iv) applications. [2]
11. a. Discuss the types of HPLC pumps. [3]
    b. Give a brief account on types of detectors used in GC. [2]
12. a. Describe how chemical shifts, coupling constants, and integration values are used to interpret NMR spectra. [3]
    b. Calculate the column resolution if two substances A and B have retention time 16.4 min and 17.6 min respectively. (Given peak width at base for A is 1.1 and for B is 1.2 min). What message on resolution can be inferred from it? [2]

13. a. Differentiate between (i) ion exchange and size exclusion chromatography (ii) normal phase and reversed phase chromatography. [3]

b. What do you know about hydride vapor generation technique and what is it good for? [2]

14. How can the zone broadening effect in column chromatography be explained on the basis of parameters mentioned in van Deemter equation? [5]

SECTION "D"

[2 Q. × 7.5 = 15 marks]

Attempt *ANY TWO* questions.

15. a. Considering atomic absorption spectroscopy (AAS), explain flame property based on fuel and oxidant. Also discuss the flame structure. Why the flame must be moved up and down for different analytes in AAS? [1+1+2.5]

b. Explain the dynamic range of an analytical measurement with a suitable figure. [3]

16. a. Write down the general principle and instrumentation of mass spectrometry. [2+2.5]

b. Explain the factors that affect the chemical shift in nuclear magnetic resonance spectroscopy. [3]

17. a. Write a note on columns used in gas chromatography. [4.5]

b. How is radiation emitted from hollow cathode lamp? What are chemical interferences and how can they be minimized? [1+2]

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Time: 30 mins.

F. M. : 10

Registration No.:

24 DEC 2024

Date :

Use of code IS 800:2007 & IS 883:1994 is not allowed in this section.

SECTION "A"

[20 Q. × 0.5 = 10 marks]

Choose and encircle in the most appropriate option from each set of choices

1. The minimum pitch required for a bolt of diameter 20mm as per IS 800:2007 is:
   a. 30mm b. 50mm c. 60mm d. 75mm

2. Tensile capacity of bolt as per IS 800:2007 is given as:
   a. $0.9f_{ub}A_n/\gamma_{mb}$ b. $0.9f_{ub}A_n\gamma_{mb}$ c. $0.78f_{ub}A_n/\gamma_{mb}$ d. $0.78f_{ub}A_n\gamma_{mb}$

3. Effective area of fillet weld is equal to:
   a. Effective length × size of weld
   b. Effective length × (2×size of weld)
   c. Effective length × (2× throat thickness)
   d. Effective length × throat thickness

4. A fillet weld is to be provided on a round edge having thickness 8mm. The maximum size of weld that can be adopted is:
   a. 5mm b. 5.5mm c. 6mm d. 6.5mm

5. A plate of width 100mm and thickness 10mm consists of 2 bolt holes of diameter 22mm. The net sectional area of plate is:
   a. 560 mm^2 b. 780 mm^2 c. 956 mm^2 d. 1000 mm^2

6. As per IS 800:2007, the design strength of tension member due to yielding is taken as:
   a. $0.9f_uA_n/\gamma_{m1}$ b. $A_g\gamma_{m0}/f_y$ c. $0.9f_u\gamma_{m1}/A_n$ d. A_gf_y/γ_{m0}

7. Which of the following statement is **CORRECT**?
   a. As the buckling class of column section increases from *a* to *d*, the design compressive stress also increases.
   b. The effective length of column depends upon the axial load on the column.
   c. As the slenderness ratio of column increases, the design compressive stress decreases.
   d. Due to buckling, the load carrying capacity of column increases.

8. As per IS 800:2007, the slenderness ratio of lacing bars shall not exceed:
   a. 180 b. 145 c. 110 d. 80

9. The compressive strength of concrete (f_{ck}) is given as 20 N/mm^2. The width of base plate is fixed as 200mm. Taking bearing strength of concrete as $0.45f_{ck}$, the length of base plate required to carry an axial load of 500 kN is:
   a. 280mm b. 250mm c. 230mm d. 200mm

10. The bending moment capacity of beam with low shear case as per IS 800:2007 is given as:

a. $\beta_b Z_p {}^{f_u}/_{\gamma_{m0}}$ b. $\beta_b A_e {}^{f_u}/_{\gamma_{m0}}$ c. $\beta_b A_e {}^{f_y}/_{\gamma_{m0}}$ d. $\beta_b Z_p {}^{f_y}/_{\gamma_{m0}}$

11. Which of the following statement is **CORRECT**?
   a. In laterally unsupported beam, the compression flange is restrained laterally.
   b. In laterally unsupported beam, the lateral buckling of the compression flange is also accompanied by twisting.
   c. The strength of laterally unsupported beam is greater than the strength of laterally supported beam.
   d. When the compression flange of beam is embedded in concrete slab, such type of beam is laterally unsupported.

12. A short timber column has a minimum side dimension of 200mm. The maximum unsupported length of column shall not exceed:
   a. 1.6m b. 1.9m c. 2.2m d. 2.5m

13. Form factor for a timber beam of square cross-section where the load is in the direction of diagonal is:
   a. 1.41 b. 1.81 c. 1.18 d. 1.5

14. For cantilever timber beams, the maximum deflection shall not exceed:
   a. Span/240 b. Span/180 c. Span/360 d. Span/120

15. Which of the following is **NOT** the modification factor for permissible stress in masonry?
   a. Stress reduction factor b. Area reduction factor
   c. Joint reduction factor d. Shape modification factor

16. Maximum slenderness ratio for a load bearing masonry column is:
   a. 8 b. 12 c. 17 d. 27

17. The area reduction factor (K_a) for masonry with section area having 0.10 m^2 is:
   a. 0.85 b. 0.55 c. 0.75 d. 0.90

18. Which of the following statement is **CORRECT**?
   a. Struts are the flexural members.
   b. Steel structures requires much time for erection and dismantling.
   c. The local buckling of plate elements of steel sections can be prevented by adopting smaller thickness of elements.
   d. The steel sections have smaller weight-to-strength ratio.

19. Permissible stress in Working Stress Design method is defined as:
   a. Ultimate stress/Factor of safety b. Ultimate stress × Factor of safety
   c. Yield stress/Factor of safety d. Yield stress × Factor of safety

20. Which of the following statement is **INCORRECT**?
   a. Dead loads, live loads, wind loads etc. are termed as indirect actions.
   b. Loads whose value doesn't change with time is called as permanent actions.
   c. Loads whose value changes with time is called as variable actions.
   d. The characteristic actions are the values of the different actions that are not expected to be exceeded with more than 5 percent probability, during the life of the structure.