BIRLA INSTITUTE OF TECHNOLOGY, MESRA, RANCHI
(END SEMESTER EXAMINATION)

CLASS: MTech **SEMESTER : II**
BRANCH: Biotechnology **SESSION : SP/22**

SUBJECT: BE508 BIOPHYSICS

TIME: **FULL MARKS: 50**

INSTRUCTIONS:
1. The question paper contains 5 questions each of 10 marks and total 50 marks.
2. Attempt all questions.
3. The missing data, if any, may be assumed suitably.
***4*. Before attempting the question paper, be sure that you have got the correct question paper.**
5. Tables/Data hand book/Graph paper etc. to be supplied to the candidates in the examination hall.

Q.1(a) Construct two-dimensional steady state diffusion equation and solve it. [3+2]
Correlate it with Brownian motion.

OR

Synthesize and solve one-dimensional time dependent diffusion equation. [3+2]
Combine it with the root mean square free path of Brownian motion, diffusion coefficient and Reynolds number.

Q.1(b) Develop a mathematical expression for molecular Force-Fields. [3+2]
Illustrate Lennard-Jones potential, Hydrogen bonding and Keesam-Debye forces.

OR

Categorize different types of Van-der-waals forces with proper mathematical expression. [2+3]
Write an expression for molecular forces for a conventional force-fileds like CHARMM.

Q.2(a) Compose the Svedberg equation for unhydrated molecule. [3+2]
Define Svedberg constant, isopycnic sedimentation.

OR

Find an expression for forces acting on a submerged particle under centrifugal force having a terminal velocity. [3+2]
A protein has a sedimentation coefficient of 7.16 S, a diffusion coefficient D = 4.45×10^{-7} cm^2 sec^{-1} and v_p = 0.73 cm^3 g^{-1} (all measured at 20°C). (a) How long will it require to migrate from r = 10 cm to r = 10.1 cm in a rotor spinning at 50,000 rpm (5×10^4 rpm)? (Assume constant velocity throughout this time). (b) What is the molecular weight of the protein?

Q.2(b) Analyze and express the methodology for following techniques, [1+2+2]
FRET, matrix assisted laser desorption/ionization (MALDI), and Quadra-pole.

OR

Analyze and express the methodology for following techniques, [3+2]
FTIR and 2D-NMR

Q.3(a) Express the 2Θ method (powder method) for X- ray diffraction crystallography. [3+2]
Summarize the principle and instrumentation of Confocal Microscopy.

OR

Compare X- ray diffraction crystallography with SEM. [3+2]
Sketch and illustrate the instrumentation of FACS (fluorescence assisted cell sorting) flow-cytometry with different data interpretation methods.

Q.3(b) Summarize and depict briefly the following bio-techniques with principle and possible application, [2 +3]
Non-contact mode AFM and Optical tweezers

OR

Summarize and depict briefly the following bio-techniques with principle and possible application, [2 +3]
Molecular interaction study with Atomic Force Microscopy; Bioimaging with Optical coherence tomography.

Q.4(a) Synthesize the Poisson-Boltzmann equation. [3+2]
Construct the Goldman-Hodgkin-Katz voltage equation for membrane potential.

OR

Interpret and compose the electrical double layer, Zeta potential and its measurement. [3+2]
Compose equilibrium membrane potential based on above equation for following ions distribution (5 mM potassium outside, 140 mM inside, 12 mM sodium inside and 140 mM outside).

Q.4(b) Compare Electro-osmosis and Electrophoresis with the Helmholtz-Smoluchowski equation. [2 +3]
Design and compose double-electrode based circuit diagram for voltage clamp. Draw the I-V graph for above the method.

OR

Build an illustrative model for generation of Action potential. Evaluate Bio-MEMS (design) with one illustration. [3 +2]

Q.5(a) Hypothesize and combine the flow electric signal across heart and ECG waveform generation. Design different leads system to measure Electrocardiogram. [3+2]

OR

Briefly illustrate with example; a) nuclear diagnostic with Radioisotopes (*In-vivo* & *In-vitro*) and b) recording of brain signal using electroencephalography. [3+2]

Q.5(b) Paraphrase and summarize the a) Electroencephalography and b) nuclear medicine with scintigraphy? [2+3]

OR

Co-relate the electrical conduction phenomena across heart and electrocardiograph waveform. What are 12-leads system for its waveform recording? [2+3]

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