

**LS5203**  
**Spring 2019**  
**MID-SEMESTER EXAMINATION**

Time: 90 minutes

Total marks: 25

Please read the questions carefully before answering.

22-02-2019

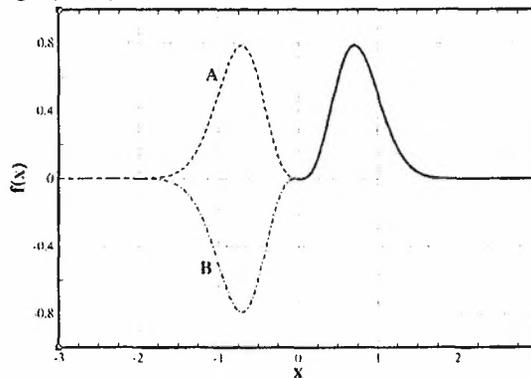
**Q1.** Consider the function  $f(x)$ , where 'A' is a constant:

$$f(x) = 10x^3 e^{-3x^2}$$

(3 + 3 + 3 marks)

i) Is the function an *even* or an *odd* function? Explain.

ii) In the diagram below, the *solid line* shows the function in the interval  $\{0, 3\}$ . Two options, 'A' and 'B', are shown in broken line for the function in the interval  $\{-3, 0\}$ . Choose the correct one, and then sketch the entire function in the range  $\{-3, 3\}$ .



iii) For the above function  $f(x)$ , evaluate the integral,

$$\int_{-1}^1 f(x) dx$$

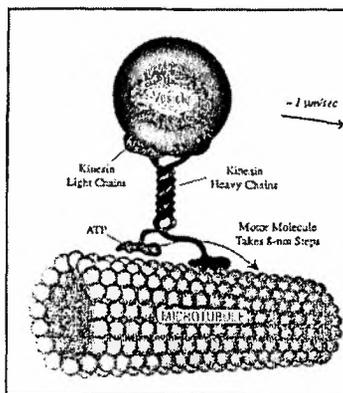
(Provide detailed explanations).

**Q2.**

(3 + 3 marks)

i) Use dimensional analysis to find how work done (W) depends on force (F) and distance covered (d).

ii) Kinesins carry loads within cells by walking along channels called microtubules. Each step size taken by a kinesin is  $\sim 8$  nm (nanometers) in length, and the energy for it is obtained via a hydrolysis of single ATP unit, which produces about  $30.5$  kJ mol<sup>-1</sup> of energy.



Assume that the entire energy used is converted to work. What is the force involved in one step, in units of piconewton (pN)? Explain your steps and all unit conversions.

*Neelanjana*  
22.2.19

**Q3.**

(3 + 3 marks)

i) A laboratory has an 18% (w/v) glucose as a stock solution stored for use in bacterial growth experiments. The molecular weight of glucose is 180 g/mol. A neighbouring lab borrows the stock solution to prepare 2 liters of 0.1 M glucose solution. Explain all the steps for preparing this solution.

ii) How will you prepare 1 liter of ampicillin solution of concentration 50 µg/ml that needs to be added to a bacterial growth medium? You have been provided with a stock solution of 200 mg/ml. Explain all steps neatly.

**Q4.**

(2 + 2 marks)

For an acid ( $HA$ ) that ionizes as  $HA \leftrightarrow H^+ + A^-$ ,

the acid dissociation constant is given as, 
$$K_a = \frac{[H^+][A^-]}{[HA]}$$

The *Henderson-Hasselbach* equation relates the pH (ie.  $-\log_{10}$  of  $[H^+]$ ) to the  $pK_a$  (ie.  $-\log_{10}$  of  $K_a$ ).

i) Derive this equation.

ii) What is the ratio of concentration of citric acid to citrate that gives a pH of 6.0, if the  $pK_a$  of citric acid is 3.13?

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