**Department of Chemical Engineering, IIT Kharagpur**

**Fluid Mechanics (CH 20001) Mid-Semester Examination, 2014**

## 2nd year B.Tech (H)/M.Tech (Dual) No. of Students 86, Time 2 Hrs., Full Marks 30

## Open Book Examination

## Only the two textbooks by the following authors are allowed

## i) Fox & McDonald and ii) Bird Stewart & Lightfoot

## Any other book(s), photocopies of text books and class notes are not allowed

There may be handwritten notes on the pages of the book but sharing of books is NOT allowed.

3. The tear film of density 1000 kg/m3 and viscosity 0.0013 (Pa.s) bathes the cornea and protects it from drying out. Treat the cornea as a vertical planar surface and assume that the tear film has a uniform thickness of h = 5 μm. Let the length of the cornea (in the flow direction) be 1 cm. Assume that a blink occurs every 5s (which replenishes the liquid layer on the surface of the cornea).

1. Find what fraction of the tear film is lost between blinks (assume steady flow between blinks)
2. The surface of the tear film has proteins that alter the surface tension and owing to this a force can develop. The force can be modeled by assuming that the surface of the tear film has become immobile. How would this alter your answer of part (a)? 3+3=6

4. An oil skimmer uses a 5 m wide x 6 m long moving belt above a fixed platform (θ = 30º) to skim oil off of rivers (T = 10ºC). The belt travels at 3 m/s. The distance between the belt and the fixed platform is 2 mm. The belt discharges into an open tank on the ship. The fluid is actually a mixture of oil and water. To simplify the analysis, assume crude oil dominates. Find the discharge of oil into the tank on the ship, the force acting on the belt and the power required (kW) to move the belt.

Tank

River with Oil Film

For oil: ρ = 860 kg/m3, viscosity, μ = 1x10 – 2N.s/m2 4+3+2=9