Ex/UNIT4.5-B2.36/2019

MASTER OF SCIENCE EXAMINATION, 2019

(2nd Year, 2nd Semester)

MATHEMATICS

UNIT – 4.5 (B - 2.36)

EPIDEMIOLOGY AND ECO-EPIDEMIOLOGY

Time : Two hours Full Marks : 50

The figures in the margin indicate full marks.

(Symbols/Notations have their usual meanings)

Answer **questions No 6** and any ***Three*** from the rest

1. What do you mean by venereal disease? Formulate a mathematical model with necessary assumptions to represent the dynamics of a venereal disease. Find all equilibrium solution of your model system and determine their stability properties. 2+6+8

2. Construct a basic SEIS model with proper assumptions. Draw a schematic diagram of your model. Under what con ditions will the epidemic grow? Determine the parametric conditions for which the endemic equilibrium will be locally asymptotically stable. 4+2+2+8

3. What do you mean by travelling wave ? If it is assumed that the disease spreads in one dimensional space with same constant diffusivity for susceptible and infected populations

then propose a partial differential equations model for SI type epidemic to obtain travelling wave. Convert your PDE model to equivalent ODE model and determine the critical wave velocity. 2+4+10

4. a) Define eco-epidemiology.

   b) Consider the following eco-epidemic model :

$$\frac{dP}{dt} = rP\left(1 - \frac{p}{k}\right) - \alpha P(S + I),$$

$$\frac{dS}{dt} = \alpha\alpha_1 PS - dS - \lambda SI,$$

$$\frac{dI}{dt} = \alpha\alpha_1 PI - (d + v)I + \lambda SI.$$

   (P = Prey, S = Susceptible predator, I = Infected predator)

   i) Find the basic reproduction number around the disease free equilibrium point of the model. Prescribe the conditions for stability of this equilibrium point. Using Bendixon-Dulac criterion, show that the disease free equilibrium is globally asymptotically stabile.

   ii) Show that the existence of positive interior steady state of the model implies its global stability. 3+8+5

5. a) Formulate an eco-epidemiological model with disease present in prey population with Holling type I functional response with necessary assumptions.

   b) Determine different steady states of your model.

   c) Study the local stability of the endemic steady state.

   7+4+5

6. Define basic reproduction number with its epidemiological significance. 2