STELLA MARIS COLLEGE (AUTONOMOUS) CHENNAI 600 086
(For candidates admitted from the academic year 2011-12 & thereafter)

SUBJECT CODE: 11MT/PE/MM44

M. Sc. DEGREE EXAMINATION, APRIL 2015
BRANCH I – MATHEMATICS
FOURTH SEMESTER

COURSE : ELECTIVE
PAPER : MATHEMATICAL MODELING
TIME : 3 HOURS **MAX. MARKS: 100**

SECTION –A

Answer all the questions: **5×2=10**

1. Explain the principle of superposition.
2. Describe the lumped element model.
3. Draw the generic schemetic of the variation of traffic velocity with density.
4. Explain the geometry of a planar pendulum.
5. Show that $\frac{1}{\lambda_H}\left(\ln\frac{H}{H_e}-\frac{H}{H_e}\right)+\frac{1}{\lambda_P}\left(\ln\frac{P}{P_e}-\frac{P}{P_e}\right)=$ Constant, using parasite-host equation.

SECTION –B

Answer any five questions: **5×6=30**

6. Explain dimensional homogeneity.
7. Explain Conservation and Balance principles.
8. In hovering, show that the power needed is proportional to $L^{7/2}$ and available power is proportional to L^2.
9. Explain Conservation of Cars.
10. Consider a flow-density relationship of the form $q(\rho)=\rho(\alpha-\beta\rho)$. The best fit of this relationship to some real traffic data occurred when $\alpha=91.33\,km/hr$ and $\beta=1.4\,km^2/car.hr$
    (a) What is the maximum density?
    (b) What is the maximum speed?
    (c) What is the capacity of the road?
11. Discuss the dissipation of energy while the pendulum is moving and obtain $\frac{dE(t)}{dt}=-cl^2\left(\frac{d\theta(t)}{dt}\right)^2$ and hence show that $E(t)=E_0e^{\left(-\frac{c}{m}\right)t}$.
12. Derive $\frac{\tilde{T}_0}{T_0}\cong 1+\frac{\theta_0^2}{16}$ for the nonlinear model of the freely-vibrating pendulum-III.

..2

SECTION –C

Answer any three questions: **3×20=60**

13. State and explain the Buckingham Pi theorem. Apply it to the Peanut butter mixer experiments and the classical pendulum experiment.
14. Describe the Scaling and Data acquisition in the cases:
    (i) rotational inertia of a wheel and
    (ii) the diagnosis of a malfunctioning electronic device.
15. Discuss, in detail, an elementary Linear – Car following model.
16. Model the free vibration of pendulum with two masses m_1 and m_2; obtain its differential equation.
    Discuss its solution in the cases : $m_2 < m_1$, $m_2 \ll m_1$, $m_2 > m_1$, $m_2 \gg m_1$ and $m_2 = m_1$
17. Obtain the Lotka-Volterra equations. Also, discuss the oscillatory solution for the Linearized Model.