2016

M.Sc.

3rd Semester Examination

APPLIED MATHEMATICS WITH OCEANOLOGY AND COMPUTER PROGRAMMING

PAPER—MTM-305

Full Marks : 50

Time : 2 Hours

The figures in the margin indicate full marks.

Candidates are required to give their answers in their own words as far as practicable.

Illustrate the answers wherever necessary.

[Special Paper : Dynamical Meteorology–I / Opertional Research Modelling–I]

(Dynamical Meteorology–I)

Answer Q. No. *8* and any *four* from the rest.

1. (a) What is planetary vorticity ? Derive the vorticity equation of an air parcel in the atmosphere and interpret each term. 7

(b) What do you mean by entropy and isentropic process ? 2

2. (a) Find the rate of change circulation in the atmosphere and interpret each term. 7

   (b) What is lifting condensation level ? 2

3. (a) Derive the Beer's law indicating the relationship between the incident radiative intensity and outgoing transmitted radiative intensity. Hence deduce the coefficient of transmission. 7

   (b) Show that the pressure tendency at the earth surface becomes zero when the air motion at all levels in the atmosphere is geostrophic. 2

4. (a) Derive the momentum equation of motion of an air parcel in the atmosphere in the spherical co-ordinate system.

   (b) What are the concepts of barotropic and baroclinic atmosphere ? 2

5. (a) Show that during the adiabatic process of an saturated air parcel in the atmosphere, the relation between equivalent potential temperature and potential temperature of the air parcel is

$$\theta_e = \theta e^{\frac{Lw_s}{C_p T}}$$

   where all symbols have their usual meanings. 7

   (b) Show that the virtual temperature is always higher than the actual temperature.

6. (a) Derive the equivalence property of Tephigram and discuss its different properties. 7

   (b) Derive the hydrostatic equation in the atmosphere. 2

7. (a) Discuss stability analysis of an air parcel in the atmosphere by Parcel Method. 8

   (b) Define potential temperature. 1

8. Answer any *two* questions : 2×2

   (a) Define relative and specfic humidity. 2

   (b) What is the difference between solar radiation and terrestrial radiation ? 2

   (c) What is the concept of coriolis force ? 2

(Internal Assessment : 10 Marks)

(Operational Research Modelling–I)

Answer Q. No. *1* and any *four* from the rest.

1. Answer any *four* questions of the following : 4×2

   (a) What are the advantages of computer simulation ?

   (b) What are the differences between CPM and PERT ?

   (c) Define the following :
   project cost, direct cost and indirect cost.

(d) What is the significance of traffic intensity in queuing theory ?

(e) What are the benefits of inventory control ?

(f) State mortality theorem related to replacement management.

2. The following are the details of estimated times of activities of a certain project :

Activity :	A	B	C	D	E	F
Immediate Predecessor :	—	A	A	B, C	—	E
Estimated time (week) :	2	3	4	6	2	8

(a) Draw the network.

(b) Find critical path and expected time of project.

(c) Calculate the earliest start time and earliest finish time for each activity. 8

3. Solve the following linear programming problem using dynamic programming method :

$$\text{Maximize } Z = 8x_1 + 7x_2$$
$$\text{Subject to } 2x_1 + x_2 \leq 8$$
$$5x_1 + 2x_2 \leq 15$$
$$x_1, x_2 \geq 0$$ 8

4. A firm has a single channel service station with the following arrival and service time probability distributions :

Inter-arrival time (in minutes)	Probability	Service time (in minutes)	Probability
10	0.10	5	0.06
15	0.20	10	0.16
20	0.35	15	0.18
25	0.25	20	0.22
30	0.10	25	0.22
		30	0.16

The customer's arrival at the service station is a random phenomenon and the time between the arrival varies from 10 to 30 minutes. The service time varies from 5 to 30 minutes. The quening process basins at 10 a.m. and proceeds for 2 hours. An arrival goes to the service facility immediately, if it is free. Otherwise it will wait in a queue. The queue discipline in first come-first served. If the attendant's wages is Rs. 100 per hour and customer's waiting time cost Rs. 150 per hour, then would it be an economical proposition to engage a second attendant ? Answer using Monte-Carlo simulation technique. 8

5. Derive the optimal ordering policy for multi-items inventory model with limited storage space. Assume that the demand rate is constant and shortages are not permitted. 8

6. The following mortality rates have been observed for a certain type of electric equipment :

Month	0	1	2	3	4	5	6
% surviving at the end of month	100	97	90	70	30	15	0

There are 10,000 items in operation. If cost is Rs. 1 to replace an individual item and 35 paise per item if all items are replaced simultaneously. It is decided all items be replaced at fixed time interval and continue replacing item (individualy) if they fail within time interval.

(i) Find the cost of replacement due to individual replacement policy.

(ii) Find the optimal time period of group replacement policy and compare it with individual replacement cost. 3+5

7. Find the optimal order quantity for a product when annual demand for the product is 500 units, the cost of storage per unit per year is 10% of the unit cost and ordering cost per order is Rs. 180. The unit costs are given below : 8

Quantity	Unit Cost (Rs.)
$0 \leq q < 500$	25.00
$500 \leq q < 1500$	24.80
$1500 \leq q < 3000$	24.60
$3000 \leq q$	24.40

(Internal Assessment : 10 Marks)