

2018

M.Sc.

4th Semester Examination

**APPLIED MATHEMATICS WITH OCEANOLOGY AND
COMPUTER PROGRAMMING**

PAPER—MTM-405 (Unit-I)

Subject Code—21

Full Marks : 25

Time : 1 Hour

The figures in the right-hand 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 : Operational Research Modelling-II/
(Dynamical Meteorology-II)**

Operational Research Modelling—II

Answer Q. No. 1 and any two from the rest.

1. Answer any two questions : 2×2
- (a) Define entropy and write its physical significance.
 - (b) State Pontryagin's maximum principle in connection with optimal control.

(Turn Over)

(c) Define reliability of a device. Also, define failure rate.

2. A transmitter and receiver has an alphabet consisting of three letters each. The joint probabilities for communication are given below :

$P(x_i, y_j)$	y_1	y_2	y_3
x_1	0.45	0.45	0.01
x_2	0.02	0.02	0.01
x_3	0.01	0.02	0.01

Find $H(X)$, $H(Y)$, $H(X/Y)$, $H(X, Y)$.

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3. A mechanical system is characterised by the following differential equations

$$\frac{dx_1}{dt} = x_2 \text{ and } \frac{dx_2}{dt} + x_2 = u,$$

where u is the control variable chosen in such a way that the cost functional

$$\frac{1}{2} \int_0^{\alpha} (x_1^2 + 4u^2) dt$$

is minimized. Show that if the boundary conditions satisfied by the state variables are $x_1(0) = a$, $x_2(0) = b$ where a, b are constants and $x_1 \rightarrow 0$, $x_2 \rightarrow 0$ as $t \rightarrow \infty$, the optimal choice for u is $u = -0.5x_1(t) - 0.414x_2(t)$.

8

4. Answer any one question :

- (a) In a system, there are n number of components connected in series with reliability $R_i(t) = p$, $i = 1, 2, \dots, n$. Find the reliability of the system. If $R_i(t) = e^{-\lambda t}$, then find the reliability of the system.

The system connected in series consist of three independent parts A, B and C which have MTBF of 100, 400 and 800 hours respectively. Find MTBF of the system and reliability of the system for 30 hours. How much MTBF of the part A has to be increased to get the improvement of MTBF of the system by 30% ? 8

- (b) There are 5 jobs each of which must go through machines A, B, C in the order ABC. Processing times are given in the following table.

Jobs	Machine A	Machine B	Machine C
1	7	6	10
2	8	3	9
3	11	1	15
4	14	2	13
5	21	5	18
6	17	4	11
7	8	1	9

Determine a sequence for five jobs that will minimize the total elapsed time. Also, calculate the total idle times for machine B and C. 8

[Internal Assessment : 05 Marks]

Dynamical Meteorology—II

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

1. Answer any *one* question : 1×2
 - (a) What is meant by global circulation in the atmosphere ? 2
 - (b) Discuss the perturbation method with a suitable example. 2

2. Deduce the linearized equations of two-dimensional internal gravity waves propagating in the $x - t$ plane neglecting the *coriolis* force. 9

3. (a) Derive the general equation of horizontal motion of air in the atmosphere including the effect of frictional forces resulting from turbulent air motion according to the Prandtl theory. 7
 - (b) Differentiate between stream line motion and turbulent motion. 2

4. (a) What are front and frontal surface ? Show that the slope of a frontal surface depends on the temperatures and velocities in two air masses. 2+5
 - (b) Write short note on CAPE. 2

[Internal Assessment : 05 Marks]