2022

M.Sc.

4th Semester Examination

APPLIED MATHEMATICS WITH OCEANOLOGY AND COMPUTER PROGRAMMING

PAPER—MTM-405

Full Marks : 25

Time : 1 Hour

The figures in the margin indicate full marks.

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

MTM-405A DYNAMICAL METEOROLOGY-II

1. Answer any *two* questions : 2×2

(a) How Jet Stream is generated in the atmosphere ?

(b) What are dynamic and kinemetic boundary conditions for a front ?

(c) Suppose temperature increases from 8°C to 12°C towards the east, across a distance of 100 km. Find the vertical gradient of geostrophic wind, given $f_c = 10^{-4}s^{-1}$.

(d) What is CAPE in the atmosphere?

2. Answer any *two* questions : 2×4

(a) Derive the conditions for frontogenesis and frontolysis.

(b) An updraft of 8 m/s exists 2 km west of your location and there is a west wind of 5 m/s. At your location there is zero vertical velocity, but the air is 3°C wanmer than the sorrounding environment of 25°C. What is the initial vertical acceleration of the air over your location?

(c) Derive the meridional temperature gradient in the atmosphere.

(d) Explain the thermodynamics of a hurricanes.

3. Answer any *one* question : 1×8

(a) Derive the perturbation equations of a two-dimensional gravity waves propagating in the x, z plane neglecting coriolis force in incompressible atmosphere.

(b) (i) Show that a front in geostrophic wind field is stationary.

(ii) Find the slope of frontal surface in the atmosphere. 2+6

[Internal assessment – 05]

MTM–405B
OPERATIONAL RESEARCH MODELLING – II

1. Answer any *two* questions : 2×2

(a) Define joint and conditional entropies.

(b) Define reliability. How does it differ from *probability ?*

(c) What do you mean by memoryless channel and channel matrix?

(d) Show that energy function H is continuous.

2. Answer any *two* questions : 2×4

(a) For any two messages X, Y prove that $H(X, Y) \leq H(X) + H(Y)$ with equality iff X and Y are independent.

(b) Suppose, a system contains a primary element and a stand-by element. Let λ_p and λ_d represent the failure rates of the primary element and stand-by element. Find the reliability of this system. Also, find the system reliability and MTBF when $\lambda_p = \lambda_d = \lambda$.

(c) A particle attached to the lower end of a vertical spring whose other end is fixed is oscillating about its equilibrium position. If x denotes the particle's displacement from the equilibrium position, the governing differential equation for

this motion is $\ddot{x} = -\omega^2 x$. If the particle is at its maximum displacement x = a at time t = 0 and at this instant of time, a force u per mass is applied to the particle in order to bring the particle to rest when its displacement is zero, find such a force u.

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

3. Answer any *one* question : 1×8

(a) Let a car be driven from a stationary position on a horizontal way to a stationary position in a garage moving a total distance a. The available control for the driver is the accelerator and the break. Find the minimum time to bring the car to the stationary position at a distance α and the optimal control to the applied to the car.

(b) Apply Shannon's encoding procedure to encode the message AADCCDBABBA using the following information :

Alphabet	A	B	C	D
Probability	0.1	0.4	0.3	0.2

[Internal assessment – 05]

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