

M.Sc. MEDICAL PHYSICS
SEMESTER -II EXAMINATION, JUNE-2026

(MPCC203) APPLIED STATISTICS AND COMPUTATIONAL TECHNIQUES

[Time allotted: Three Hours]

[Max Marks: 100]

Note: Read all the instructions carefully

Answer all questions in serial order, Draw suitable diagrams wherever necessary

Q. 1. Objective type questions: (Attempt All)**(10 x 02 = 20)**

(Very short/ Short answer/ MCQ/ One liners/ Fill in the blanks/ True/False)

- a. What is a confidence interval? [CO:1; PO:5]
- b. Write fourth-order Runge-Kutta method formula. [CO:2; PO:5]
- c. State trapezoidal rule formula. [CO:4; PO:5]
- d. State the central limit theorem. [CO:4; PO:5]
- e. Mention one method of generating random numbers. [CO:4; PO:5]
- f. What is the purpose of tests for randomness? [CO:2; PO:5]
- g. What is the main strength of Mathematica? [CO:5; PO:5]
- h. The absorbed radiation doses (in mGy) for four patients were measured as: 2.5, 3.0, 2.8, 3.2. Determine the mean and median absorbed dose. [CO:3; PO:5]
- i. Name two types of analyses possible in STATISTICA. [CO:3; PO:5]
- j. What is a continuous random variable? [CO:3; PO:5]

Q. 2. Short notes/ Short answer type questions (Attempt any Five)**(05 x 04 = 20)**

- a. What is the role of AI in radiation oncology treatment planning? [CO:3; PO:5]
- b. What are computational packages and why are they important in research? [CO:3; PO:5]
- c. Define signal-to-noise ratio (SNR) in radiation detection. [CO:3; PO:5]
- d. In a family there are two children. Find the probability for different cases:
 (i) Elder child is girl; (ii) younger child is girl; (iii) Both are girl; (iv) Both are opposite gender. [CO:1; PO:5]
- e. Explain the inversion random sampling technique with an example. [CO:3; PO:5]
- f. State the axiomatic approach to probability. [CO:3; PO:5]
- g. Explain the role of regression analysis in medical physics research. [CO:3; PO:5]

Q. 3. Structured questions (Attempt any Three)**(03 x 10 = 30)**

- a. The following table gives the values of e^x for certain equidistant values of x . find the value of e^x when $x=0.644$ [CO:3; PO:5]

x	0.61	0.62	0.63	0.64	0.65	0.66	0.67
y= e^x	1.840431	1.858928	1.877610	1.896481	1.915541	1.934792	1.954237

- b. The following data show the exposure time (ms) and patient entrance skin dose (mGy) measured during radiographic imaging: [CO:3; PO:5]

Exposure Time (ms)	5	10	15	20	25	30
Dose (mGy)	1.0	2.0	3.1	3.9	5.1	6.0

Find the Pearson correlation coefficient and comment on the relationship.

- c. Explain the concept of measures of central tendency. The following grouped data represent half-life values of a radioactive isotope measured in repeated experiments: [CO:3; PO:5]

Half-life (min)	8-10	10-12	12-14	14-16	16-18
Frequency (f)	3	7	10	6	4

Calculate the **Geometric Mean (GM)** of the half-life.

- d. Patients undergoing two different types of therapy were studied for recovery status. [CO:3; PO:5]

Therapy Type	Recovered	Not Recovered	Total
Therapy X	45	15	60
Therapy Y	30	30	60
Total	75	45	120

Test whether **recovery is independent of therapy type** at 5% level of significance. (tabulated value at 5% level of significance=3.84)**P.T.O.....**

Q. 4. Long Answer/ Essay type questions (Attempt any Two)**(02 x 15 = 30)**

- a. Two dosimeters measured absorbed dose (mGy) in the same five patients. The readings are: [CO:3; PO:5]

Dosimeter A:	2.5	2.8	3.0	3.2	2.9
Dosimeter B:	2.7	2.6	2.9	3.1	2.8

Test whether the two dosimeters give significantly different readings at the 5% significance level. Also, Comment on agreement between the dosimeters. (tabulated value = 2.776)

- b. A random variable X has the following probability function value of X: [CO:3; PO:5]

Value of X, x	0	1	2	3	4	5	6	7
P(x)	0	k	2k	2k	3k	K ²	2k ²	7k ² +k

- (i) Find k; evaluate $p(X < 6)$; $p(X \geq 6)$ and $P(0 < X < 5)$
(ii) If $P(X \leq a) > \frac{1}{2}$, find the minimum value of a
(iii) Determine the distribution function of X
- c. A study was conducted to examine the relationship between hours of radiation exposure per week (X) and fatigue score on a standardized scale (Y) in radiology technicians.

Data from 6 technicians are as follows:

[CO:3; PO:5]

Technician	Hours of Exposure per week (X)	Fatigue Score (Y)
1	8	40
2	6	35
3	10	48
4	9	45
5	5	30
6	7	38

- (i) Fit a simple linear regression line of Y on X.
(ii) Interpret the slope in context of the data.
(iii) Estimate the fatigue score for a technician working 8 hours per week.