

## MANIPAL UNIVERSITY

**FIRST YEAR M.Sc. N.M.T. DEGREE EXAMINATION – MAY/JUNE 2012**  
**SUBJECT: PAPER – IV: ADVANCED BIOSTATISTICS & RESEARCH METHODOLOGY**  
**(NEW REGULATION)**  
 Tuesday, May 29, 2012

Time: 10:00 – 13:00 Hrs.

Max. Marks: 80

✍ **Answer ALL the questions.**

- 1A. Define mean, median, mode, standard deviation and coefficient of variation for 'n' observations.
- 1B. Explain stratified random sampling method. (5+5 = 10 marks)
2. Fifty patients with congestive heart failure were weighed before and after receiving a novel diuretic agent and the average weight loss (the difference between the two weights) for this sample was found to be 3.5 KG with a standard error of 2.6 Kg.
- 2A. Name the statistical test used for testing whether the agent is effective in reducing the weight.
- 2B. State the null and alternate hypothesis.
- 2C. Write the test statistic for this test.
- 2D. Mention the assumptions for the validity of this test.
- 2E. How do you take a decision on the acceptance or rejection of null hypothesis? (2×5 = 10 marks)
- 3A. What do you mean by sampling distribution and standard error? What are the factors that affect the width of a confidence interval for mean?
- 3B. Write a short note on binomial distribution. ((2+3)+5 = 10 marks)
4. What do you mean by randomization in randomised controlled trials (RCTs)? Explain different methods of randomization in RCTs. (1+9 = 10 marks)
- 5A. A hospital administrator wishes to estimate the mean weight of babies born in the hospital. How large a sample of birth records should be taken if the administrator wants a 95% confidence interval with margin error of 1.2 Kg? Assume that a reasonable estimate of the population standard deviation is 5 Kg.
- 5B. Write a short note on cross sectional study design. (5+5 = 10 marks)
6. Explain the structure of a research thesis. (10 marks)
7. **Write short notes on:**
- 7A. Chi square test
- 7B. Survival analysis
- 7C. Validity of a diagnostic test
- 7D. One way ANOVA (5×4 = 20 marks)



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**MANIPAL UNIVERSITY**

**FIRST YEAR M.Sc. NMT DEGREE EXAMINATION – MAY/JUNE 2012**

**SUBJECT: PAPER I: ANATOMY AND PHYSIOLOGY**

Thursday, May 31, 2012

Time: 10:00 – 13:00 Hrs.

Max. Marks: 80

✍ **Answer ALL questions.**

✍ **Write short notes on:**

1. Spleen
2. Function of the Lymphatic system
3. Esophagus gross anatomy and radionuclide motility study
4. Salivary glands
5. Coronary Arterial System
6. Neuron
7. Glomerular Filtration rate
8. Calcitonin

(10×8 = 80 marks)



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## MANIPAL UNIVERSITY

FIRST YEAR M.Sc. N.M.T. DEGREE EXAMINATION – MAY/JUNE 2012

SUBJECT: PAPER II: BIOCHEMISTRY  
(NEW REGULATION)

Saturday, June 02, 2012

Time: 10:00 – 13:00 Hrs.

Max. Marks: 80

✍ **Answer ALL questions.**

1. **Write short notes:**

- 1A. Bacterial growth culture
- 1B. Difference between humoral immunity and cell mediated immunity
- 1C. Production of antibodies
- 1D. Endoplasmic Reticulum
- 1E. Tumours classification
- 1F. Deficiency diseases of Vitamins A,D,C

(10×6 = 60 marks)

2. Brief about Liposomes. Classify the different types of liposomes. What are the different methods of the production of liposomes? Brief any one method.

(10 marks)

3. What are the characteristics of a pure protein? Classify Proteins on the basis of their structure.

(10 marks)



## MANIPAL UNIVERSITY

FIRST YEAR M.Sc. N.M.T. DEGREE EXAMINATION – MAY/JUNE 2012

SUBJECT: PAPER III: MATHEMATICS IN NUCLEAR MEDICINE

(NEW REGULATION)

Monday, June 04, 2012

Time: 10:00 – 13:00 Hrs.

Max. Marks: 80

✍ Answer any EIGHT questions of the following:

1A. If  $\sin A = 4/5$  and  $\pi/2 < A < \pi$  find the value of  $\frac{3 \sin A - \cos A}{4 \operatorname{cosec} A + 3 \tan A}$ .

1B. Prove that  $\lim_{\theta \rightarrow 0} \frac{\sin \theta}{\theta} = 1$

1C. Explain sin graph.

1D. Prove that:  $\log_4 2 + \log_8 2 + \log_{16} 2 = 7/12$

(3+3+2+2 = 10 marks)

2A. In vector product if  $a = i - 2j + 3k$ ;  $b = 2i + j + k$  find:

- The unit vector perpendicular to both a and b
- Sine of the angle between the vectors

2B. Find the equation of the tangent to the curve  $y^2 = 3 - 5x$  parallel to the line  $5x - 4y + 13 = 0$

(5+5 = 10 marks)

3A. Find the inverse of square matrix  $A = \begin{bmatrix} 1 & 3 & 2 \\ 0 & 1 & 2 \\ 2 & 1 & 3 \end{bmatrix}$

3B. Solve  $\frac{(\cos 3\theta + i \sin 3\theta)^5 (\cos 2\theta - i \sin 2\theta)^3}{(\cos 4\theta + i \sin 4\theta)^2 (\cos 5\theta - i \sin 5\theta)^4}$

(6+4 = 10 marks)

4A. Find Laplace transforms of  $\sin 2t$ ,  $\sin 3t$ .

4B. Find the second derivative of the  $6x^3 + 3x^2 + 2x + 5$

4C. Derive differential equation by eliminating the arbitrary constant a.  $r = a(1 - \cos \theta)$

(4+3+3 = 10 marks)

5A. Evaluate:  $\int_0^{\pi/2} x \cos x \, dx$

5B. Integrate  $\tan^4 x$

(5+5 = 10 marks)

6A. Define one-one function, onto function, one-to-one function and even function.

6B. Assuming that the following values of y belong to a polynomial of degree 4 compute the next three values by using Finite Forward Differences.

X	0	1	2	3	4	5	6	7
y	1	-1	1	-1	1	-	-	-

(2+8 = 10 marks)

7A. A Nuclear Medicine technologist performs a procedure with 150mCi Tc-99m source maintaining an average distance of 30cm for 10 min. What is the radiation exposure received by him/her?

7B. The activity of Tc-99m at the time of disposed in lead dustbin was 0.5 mCi. What is the activity after 10 days when it was sent for disposal along with general non radioactive waste? Write your answer in uCi.

(5+5 = 10 marks)

8A. Convert 37 GBq into mCi.

8B. While handling a Cs -137 with remote handling tongs of length 50cm the operator receives 10mR in a period of 5 minutes. What would be the exposure, if he uses a 2m tongs and handles the source for 10 minutes?

8C. Calculate the exposure rate at 1 mtr from a 2Ci Mo-99 source (unshielded).

(2+5+3 = 10 marks)

9A. Explain the use of Radon transformation in Nuclear Medicine.

9B. Explain compartment analysis with example.

(5+5 = 10 marks)



**MANIPAL UNIVERSITY**  
**FIRST YEAR M.Sc. NMT DEGREE EXAMINATION – MAY/JUNE 2012**  
**SUBJECT: PAPER V: COMPUTERS IN NUCLEAR MEDICINE**

(NEW REGULATION)  
Wednesday, June 06, 2012

Time: 10:00 – 13:00 Hrs.

Max. Marks: 80

☞ Answer ALL the questions.

1. Explain in detail about significance of image processing in Nuclear Medicine. (10 marks)
2. Describe the advantages and disadvantages of internet. (10 marks)
3. Explain transmission modes in networking. (5 marks)
4. Explain the basic or fundamental data types in “C” with their storage allocation. (5 marks)
5. Write a C program to calculate the area of a rectangle. (5 marks)
6. Write short notes on the following:  
i) Matrix Size    ii) Memory    iii) Time Activity Curve    iv) Output Devices  
v) ADC    vi) Software    vii) Bus    viii) RIS computers  
(5×8 = 40 marks)
7. What does it mean by static and dynamic acquisitions in Nuclear Medicine? Is it significant to study about the byte and word mode? Justify. (5 marks)



**MANIPAL UNIVERSITY**  
**FIRST YEAR M.Sc. NMT DEGREE EXAMINATION – MAY/JUNE 2012**  
**SUBJECT: PAPER VI: BIOMEDICAL ELECTRONICS**

(NEW REGULATION)

Friday, June 08, 2012

Time: 10:00 – 13:00 Hrs.

Max. Marks: 80

✍ **Answer ALL the following questions.**

✍ **Draw suitable circuit diagram, block diagram, waveform or characteristics wherever it is necessary.**

1A. Explain Energy band in solid and explain the classification of materials based on energy band.

1B. Briefly explain about semiconductor doping.

1C. Explain Zener diode and its IV characteristic curve.

(4+2+4 = 10 marks)

2A. What is FET? Write the uses of FET.

2B. Write a short note on inductors.

2C. Explain pinch-off in JFET.

(5+2+3 = 10 marks)

3A. Explain low pass filters.

3B. Write the common power problem and explain the alternate.

(5+5 = 10 marks)

4A. Explain Inverting and Non-inverting OP-AMP.

4B. Explain PMT.

(5+5 = 10 marks)

5A. What is amplifier? Briefly explain different types of amplifier.

5B. Explain AND gate, NOT gate and NAND gate.

(5+5 = 10 marks)

6A. What is equivalent circuit? Explain Norton circuit.

6B. Explain ADC.

(4+6 = 10 marks)

7A. Briefly explain half-wave rectifier.

7B. Explain pre-amplifier.

7C. Explain Multivibrator.

(3+4+3 = 10 marks)

8A. Explain pulse shaping.

8B. Explain amplifier distortion.

8C. Define coincidence and anti-coincidence circuit.

(4+4+2 = 10 marks)



**MANIPAL UNIVERSITY****FIRST YEAR M.Sc. NMT DEGREE EXAMINATION – MAY/JUNE 2012****SUBJECT: PAPER VII: RADIATION PHYSICS**

Monday, June 11, 2012

Time: 10:00 – 13:00 Hrs.

Max. Marks: 80

✍ **Answer ALL questions. All questions carry TEN marks.**

**1. Define the following:**

- 1A. Cerenkov radiation
- 1B. Intrinsic efficiency
- 1C. Decay constant
- 1D. Binding energy
- 1E. Annihilation

2. Explain the principle and mechanism of Liquid Scintillation Counting.

3. Derive the Bateman equation.

4A. What is HVL and TVL? How are they related?

4B. What is thickness of the Lead required to reduce the exposure of point source of  $^{131}\text{I}$  by 70%?

5. Explain about the different components of the Reactor. Give five examples of reactor produced radionuclides with their half-lives.

6. What is gamma-ray spectroscopy? With the help of neat and labelled spectra, explain the various peaks.

7A. What is the difference between orbital electron binding energy and nuclear binding energy of an atom?

7B. Write short notes on: **(any one)**

i) Alpha decay

ii) Electron capture

8.  $^{90}\text{Y}$  produces bremsstrahlung radiations. How do you justify this statement? Give reason. As a health physicist do you bother about these radiations?





## MANIPAL UNIVERSITY

## FIRST YEAR M.Sc. NMT DEGREE EXAMINATION – MAY/JUNE 2012

## SUBJECT: PAPER VIII: RADIOPHARMACY – I

Wednesday, June 13, 2012

Time: 10:00 – 13:00 Hrs.

Max. Marks: 80

✍ Answer ALL Questions.

1. Write in very short about the following:

- 1A. Buffer solution
- 1B. Sublimation
- 1C. Radioisotopes
- 1D. Bronsted base
- 1E. Covalent Bonding
- 1F.  $^{15}\text{O}$  labeled Water
- 1G. (n- $\gamma$ ) nuclear reaction
- 1H. Autoclave
- 1I. Normality
- 1J. Laminar air flow Bench

(2×10 = 20 marks)

- 2A. List the various chemical separation methods used in lab and their examples (no details).
- 2B. Describe the protocol for the preparation of any one myocardial perfusion imaging radiopharmaceutical.
- 2C. Describe the biodistribution of sodium pertechnetate in humans administered through both oral and intravenous route.
- 2D. Describe Bohr atomic model and their limitation.

(5×4 = 20 marks)

- 3A. Write the principle and important steps in the separation of  $^{99\text{m}}\text{Tc}$  from  $^{99}\text{Mo}$  in a solvent extraction generator. Mention its advantages and disadvantages.
- 3B. Describe the principle of paper chromatography used to check quality of Radiopharmaceuticals. What are the advantages and disadvantages of miniature chromatography?
- 3C. Why Fluorine-18 radiotracers are considered as “workhorse” of PET imaging? Why automatic synthesis modules are required in radiochemistry lab?
- 3D. Define Cold kit with reference to radiopharmaceuticals. Explain importance of reducing agents, antioxidants and stabilizers in cold kits of  $^{99\text{m}}\text{Tc}$  Radiopharmaceuticals.

(10×4 = 40 marks)



## MANIPAL UNIVERSITY

FIRST YEAR M.Sc. NMT DEGREE EXAMINATION – MAY/JUNE 2012

SUBJECT: PAPER IX: NUCLEAR MEDICINE INSTRUMENTATION – I

Friday, June 15, 2012

Time: 10:00 – 13:00 Hrs.

Max. Marks: 80

✍ Answer ALL the questions. All questions carry TEN marks.

## 1. Write short notes on:

- 1A. Liquid scintillation cocktail solution
- 1B. Sample volume effect

- 2. Explain the performance characteristics of GM counter.
- 3. Explain the working principle of Isotope calibrator. Write about any two QC test carried out in the justifying the importance of the test in your routine practice.
- 4. With the help of a neat and labelled diagram mention the **components and its functions** used in a rectilinear scanning system.
- 5. You have taken a swipe sample from the sink of radio pharmacy lab. How will you determine the activity and isotope in the sample?
- 6. What all parameters will you consider during the installation of a thyroid uptake probe? Give reasons in support of your answer.
- 7. Explain about the principle, design and calibration of whole body counters.
- 8A. Explain the Rose Model equation in imaging.
- 8B. Preliminary measurements in a sample counting procedure indicate gross and background counting rate of  $R_g=900$  cpm  $R_b = 100$  cpm respectively. Find optimal of a 1.25 minute total counting time and the resulting uncertainty in the net sample counting rate.



# MANIPAL UNIVERSITY

**FIRST YEAR M.Sc. N.M.T. DEGREE EXAMINATION – DECEMBER 2012**

**SUBJECT: PAPER III: MATHEMATICS IN NUCLEAR MEDICINE  
(NEW REGULATION)**

Monday, December 17, 2012

Time: 10:00 – 13:00 Hrs.

Max. Marks: 80

✍ **Answer any EIGHT questions of the following:**

1A. If  $\operatorname{cosec} A = -13/12$  and  $180 < A < 270$  find the value of  $\frac{4 \sin A + \cos A}{8 \sin A + 2 \cos A}$ .

1B.  $A = \begin{bmatrix} 2 & -3 & 0 \\ 1 & 4 & -1 \end{bmatrix}$ ,  $B = \begin{bmatrix} 6 & 1 \\ 3 & 0 \\ 5 & 2 \end{bmatrix}$  Show that  $(AB)' = B'A'$ .

1C. Find the scalar product of the vectors  $a = 2i - 2j + k$  and  $b = 2i - 3j + 6k$ . Also find the cosine of the angle between  $a$  and  $b$ .

(2+4+4 = 10 marks)

2A. Explain log-log graph, semilog graph, logit log graph and write the use in Nuclear Medicine.

2B. Solve the simultaneous equation  $0.6x - 0.8y = 0.5$ ;  $0.9x + 0.7y = 1.7$ .

2C. Differentiate:  $\frac{x \log x}{x-1}$  w.r.to  $x$ .

2D. Differentiate:  $y = \log (\tan e^x)$ .

(3+2+3+2 = 10 marks)

3A. Find out tangent and normal equations for:  $x^3 - 3xy + y^3 = 17$  at point  $(2, 3)$ .

3B. Differentiate  $\sin x$  by first principle of derivative.

3C. Explain iterative reconstruction algorithms in Nuclear Medicine.

(3+3+4 = 10 marks)

4A. Express the complex number  $\frac{(1+i)(1+2i)}{1+3i}$  in the polar form and hence find their modulus and amplitude.

4B. Prove that:  $\lim_{x \rightarrow a} \frac{x^n - a^n}{x - a} = n a^{n-1}$ .

(5+5 = 10 marks)

5A. Find the maxima and minima of the function  $2x^3 - 12x^2 + 18x + 5$ .

5B. Explain the use of Radon transformation in Nuclear Medicine.

(5+5 = 10 marks)

6A. Integrate  $\tan^4 x$ .

6B. Evaluate  $\int_0^{\pi/2} x \sin^2 x \, dx$ .

(5+5 = 10 marks)

7A. The activity Tc99m at the time of disposal in lead dustbin was 0.5 mCi. What is the activity after 10 days when it was sent for disposal along with general non-radioactive waste and write the answer in Curie.

7B. Find exposure level at 80cm from 150 mCi I-131 kept in a lead pot having thickness of 3cm.

(5+5 = 10 marks)

8A. Convert 250 mCi into GBq.

8B. Deduce the appropriate compartment model.

$$dV_1/dt = k_{01}V_0 + k_{21}V_2 + k_{41}V_4 - k_{12}V_1 - k_{14}V_1$$

$$dV_2/dt = k_{12}V_1 - k_{21}V_2 - k_{23}V_2 ; \quad dV_3/dt = k_{23}V_2 - k_{30}V_3 ;$$

$$dV_4/dt = k_{14}V_1 - k_{41}V_4 - k_{45}V_4 ; \quad dV_5/dt = k_{45}V_4 - k_{50}V_5$$

8C. 500 mCi of I-131 is available on Monday at 12 noon. 2 patients are treated with 100 mCi and 75 mCi on the same day at 12 noon. What is the remaining activity available on following Saturday at 10 am.

(2+5+3 = 10 marks)

9A. The table gives the distances in cm of the visible horizon for the given heights in inch above the detector surface:

X= height	10	15	20	25	30	35	40
Y= distance	11	13	15	16	18	19	21

Find the value of y when  $x = 22$  by using Newton's interpolation formula.

9B. Write the formula of Simpson's 1/3 rule, Simpson's 3/8 rule.

9C. Find the Laplace transform of:  $\sin 2t \cdot \sin 3t$ .

(5+2+3 = 10 marks)



**MANIPAL UNIVERSITY****FIRST YEAR M.Sc. NMT DEGREE EXAMINATION – DECEMBER 2012****SUBJECT: PAPER VII: RADIATION PHYSICS  
(NEW REGULATION)**

Tuesday, December 18, 2012

Time: 10:00 – 13:00 Hrs.

Max. Marks: 80

✍ **Answer ALL questions. All questions carry TEN marks.**

1. Define and add a note on each in not more than two lines.
  - 1A. Range
  - 1B. Specific Ionisation
  - 1C. LET
  - 1D. Stopping power
  - 1E. Bremsstrahlung
  
2. Explain radionuclide equilibrium and derive the equation for it.
  - 3A. What is half value layer, linear attenuation coefficient and mass attenuation coefficient?
  - 3B. What is thickness of the Lead required to reduce the exposure of point source of  $^{99m}\text{Tc}$  by 70%?
  
4. Explain the principle of Gas filled detector.
  - 5A. Prove that for relatively low photon energies the recoil electron receives only a small fraction of the incident photon energy even in  $180^\circ$  scattering events.
  - 5B. Backscatter peak and Compton edge are same in a pulse height spectrum. Justify this statement.
  
- 6A. In brief explain how neutrons interact with matter.
- 6B. Explain the principle of Liquid Scintillation counting.
  
7. Briefly discuss about the different interactions of non-ionizing radiations with matter.
  
8. Write short notes on any **TWO**:
  - 8A. Bohr's atomic model
  - 8B. Trilinear chart
  - 8C. Nuclear stability



## MANIPAL UNIVERSITY

## FIRST YEAR M.Sc. NMT DEGREE EXAMINATION – DECEMBER 2012

## SUBJECT: PAPER IX: NUCLEAR MEDICINE INSTRUMENTATION – I

Wednesday, December 19, 2012

Time: 10:00 – 13:00 Hrs.

Max. Marks: 80

✍ **Answer ALL the questions.**

1. With the help of a neat and labelled diagram mention the components and its functions used in a rectilinear scanning system. Explain the characteristics of the collimator.  
(20 marks)
2. In brief explain the working principle as well as compare and contrast between photomultiplier tube and photodiodes.  
(20 marks)
3. What are isotope calibrators? Explain its working principle with the help of a neat and labelled diagram.  
(10 marks)
4. Why the patient is not placed as close to the detector face for the thyroid uptake study? Explain with the help of diagram/s.  
(10 marks)
5. As a Nuclear Medicine Technologist what are the features to be considered for an ideal intraoperative gamma probe?  
(5 marks)
6. **Write short notes on the following:**
  - 6A. Coincidence circuit.
  - 6B. Calibration Sources.
  - 6C. Accuracy and Precision of dose calibrator.

(5×3 = 15 marks)

