

Enrollment No. [REDACTED]

S<sub>4</sub>(UBE04C17)BE

B.Tech 4<sup>th</sup> Semester End-Term Examination, 2018-19  
Numerical Methods  
Paper Code: UBE04C17

Full Marks: 100

Time: 3 hours

The figures in the margin indicate full marks for the questions

**Part-I (40 marks)**

*Answer any four questions in the following*

- ✓ 1. Solve the following set of equations using Gauss-Siedel method till percent relative error falls below  $\epsilon_s = 5\%$ :

$$\begin{aligned} 8x_1 + 4x_2 - x_3 &= 11 \\ -2x_1 + 5x_2 + x_3 &= 4 \\ 2x_1 - x_2 + 6x_3 &= 7 \end{aligned} \quad (10 \text{ marks})$$

2. Solve the following initial value problem over the interval from  $t=0$  to  $1$ , where  $y(0)=1$ . Plot all your results on the same graph and compare their predictability using Euler's method with  $h=0.25$ .

$$\frac{dy}{dt} = (1 + 2t) \sqrt{y} \quad (10 \text{ marks})$$

- ✓ 3. Solve the following initial value problem over the interval from  $t=0$  to  $1$ , where  $y(0)=1$ . Plot all your results on the same graph and compare their predictability.

$$\frac{dy}{dt} = yt^3 - 1.5y \quad (10 \text{ marks})$$

Use midpoint method with  $h=0.25$

4. Compute  $f(12.2)$  from the data using appropriate interpolation technique (10 marks)

x	10	11	12	13	14
f(x)	0.23967	0.28060	0.31788	0.35209	0.38368

- ✓ 5. Compute  $f(0.71)$  from the data using appropriate interpolation technique (10 marks)

x	0.70	0.72	0.74	0.76	0.78
f(x)	0.84229	0.87707	0.91309	0.95045	0.98926

- ✓ 6. From the following table, find the area bounded by the curve and x-axis, between the ordinates  $x=7.47$  to  $x=7.52$ . (10 marks)

x	1.0	1.1	1.2	1.3	1.4	1.5	1.6
f(x)	7.989	8.403	8.781	9.129	9.451	9.750	10.031

*Part-II (60 marks)*  
*Answer all the questions*

1. Solve the initial value problem given below with 4<sup>th</sup> order Adams method, which uses 4<sup>th</sup> order Adams-Bashforth formula as predictor equation and 4<sup>th</sup> order Adams Moulton formula as corrector equation from t=4 to 5 using a step size of 0.5. (30 marks)

$$\frac{dy}{dt} = -\frac{2y}{t}$$

Given initial values are  $y(2.5)=0.48$ . Find out the other initial values using RK method. An n-th order Adams-Bashforth formula is given by,

$$y_{i+1} = y_i + h \sum_{k=0}^{n-1} \beta_k f_{i-k}$$

An n-th order Adams-Moulton formula is given by,

$$y_{i+1} = y_i + h \sum_{k=0}^{n-1} \beta_k f_{i+1-k}$$

The relevant coefficients are given as,

	$\beta_0$	$\beta_1$	$\beta_2$	$\beta_3$
Adams-Bashforth	55/24	-59/24	37/24	-9/24
Adams-Moulton	9/24	19/24	-5/24	1/24

2. Solve the following: (2x15=30 marks)

(a) Derive the following expressions using Newton's Forward interpolation formula:

$$\left[ \frac{dy}{dx} \right]_{x=x_0} = \frac{1}{h} \left[ \Delta y_0 - \frac{\Delta^2 y_0}{2} + \frac{\Delta^3 y_0}{3} - \frac{\Delta^4 y_0}{4} + \dots \right]$$

$$\left[ \frac{d^2y}{dx^2} \right]_{x=x_0} = \frac{1}{h^2} \left[ \Delta^2 y_0 - \Delta^3 y_0 + \frac{11}{12} \Delta^4 y_0 - \frac{5}{6} \Delta^5 y_0 + \dots \right]$$

*12x  
240*

(b) For the given polynomial, find out  $\frac{dy}{dx}$  and  $\frac{d^2y}{dx^2}$  at  $x=1.1$  and  $x=1.5$

$x$	1.0	1.1	1.2	1.3	1.4	1.5	1.6
$f(x)$	7.989	8.403	8.781	9.129	9.451	9.750	10.031

B.Tech 4<sup>th</sup> Semester End Term Examination, 2019  
 Animal Cell Biotechnology and Genetics  
 Paper Code: UBE04B06

Full Marks: 100

Time: 3 hours

Answer all Questions in the following orders:

1. a) Listed below are three different single strands of DNA, which of these, in their double stranded form would you expect to be cleaved by a restriction endonucleases and highlight the site?

(i) GACTCGGGATCCCCTCC (ii) TGCCTCATTGAAAGCCTG (iii) CACTCCACCACGTGCTCCA

- b) A linear DNA molecule is subjected to partial and fully digestions with restriction endonucleases, and following results are obtained. Draw the restriction map defined by these data.

<u>Enzymes</u>	<u>Fragment Size (in kb)</u>
EcoRI	2.5, 1.5, 6.0 = 10
HindIII	4.5, 4.5, 1.0 = 10
EcoRI + HindIII	2.5, 1.5, 0.5, 4.5, 1.0 = 10

$$(3 \times 2) + 4 = 10$$

- 2) a) In human genome (haploid) contains about  $3.5 \times 10^9$  nucleotide pairs of DNA. If you digest a preparation of human DNA with SmaI, a restriction endonuclease that recognizes and cleaves the hexameric sequence 5'-CCCGGG-3'. How many different restriction fragments would you expect to produce? Assume that the four base (A, T, G, and C) are equally prevalent and randomly distributed in the human genome.

b) i) Starting with DNA from a somatic cell, how many copies of a specific gene sequence (hemezygous) will be obtained after 10 cycles of PCR amplification?

ii) If the above gene is sex chromosome related gene sequence, how many copies of that gene will be obtained after 12 cycles of PCR amplification?

$$6 + (2+2) = 10$$

3) a) Distinguish between primary cell and immortal cell line?

b) Flower colour in a garden plant is under the control of a gene with multiple allele. The phenotypes of the homozygote and heterozygote of this gene are as follows:

<u>Homozygotes</u>	<u>Heterozygotes</u>
WW - Red	W with any other allele - Red
ww - Pure white	w <sup>P</sup> with either w <sup>S</sup> or w - White with regular red patches
w <sup>S</sup> w <sup>S</sup> - white stippled with red	w <sup>S</sup> w - white stippled with red
w <sup>P</sup> w <sup>P</sup> - white with regular red patches	

Arrange the allele in a dominance hierarchy.

$$4 + 6 = 10$$

- 4) a) Why is serum usually required in the media used to grow animal cells in culture?

b) Two independently discovered strain of mice are homozygous for a recessive mutation that causes the eye to be small, the phenotype of two strains are indistinguishable. The mutation in one strain is called little gene, and the other mutation in other strain is called tiny eye. How would you determine if the little eye, tiny eye mutations are alleles of the same gene?

c) What is co-dominance?

$$3 + 5 + 2 = 10$$

5) a) Human cellular mitochondrial DNA and Nuclear DNA – what are the differences?

b) Write a short note on Leber's Hereditary Optic Neuropathy (LHON).

c) In human being, the gene for  $\beta$ -globin is located on chromosome 11, and the gene for  $\alpha$ -globin, which is another component of the haemoglobin protein, is located on chromosome 16. Would these two chromosomes be expected to pair with each other during meiosis? Explain your logic.

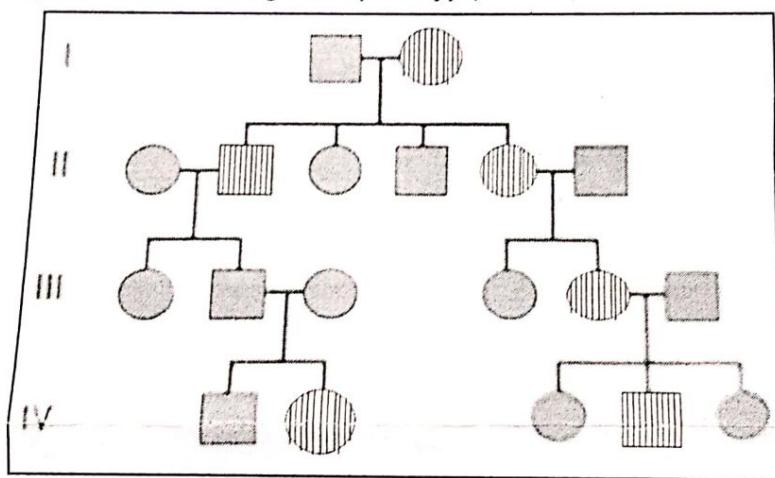
$$3+4+3 = 10$$

6) a) In a few sentences, what are the Mendel's key idea about inheritance?

b) What is the critical feature of a cloning vector that would allow you to isolate stably transfected mammalian cells?

$$6+4=10$$

7) a) The pedigree below shows the inheritance of ataxia, a rare neurological disorder characterized by uncoordinated movement. Is ataxia caused by a dominant or a recessive allele? Explain. (Dashed circle and dashed box are indicating individuals showing ataxia phenotype).



b) Write down the genotype and phenotype of Down syndrome and Klinefelter syndrome.

$$6+(2+2)=10$$

8) a) How will you preserve animal cells in your laboratory for storage purpose?

b) What does it mean by cloning efficiency of a primary cells is 30%?

c) You have two different cell lines, one is having 75% and another one is having 92% seeding efficiency. You can use either of any for your experiment. Explain which one will be good for your experiment.

d) Why the organotypic culture is difficult in laboratory conditions?

e) Why serum is inactivated by heat ( $55^{\circ}\text{C}$  for 30 min) before mixing in animal cell culture media?

$$2 \times 5 = 10$$

9) a) Write down the principle technology of RNA interference (RNAi).

b) Write down the detail mechanism of different transposable elements.

$$10+5=15$$

**B.Tech. 4<sup>th</sup> Semester End-Term Examination 2019**  
**Subject Name: Principles of Management and Managerial Economics**  
**Subject Code: UBE04C18**

Full marks: 100

Time: 3 hours

*The figures in the margin indicate full marks***Answer all Questions.**

1. Define Budget and Budgetary control. Discuss the objectives of Budgetary Control. (1+1+5=7)
2. What do you mean by Finance? Discuss the various sources of finance. (1+4=5)
3. Write short notes on:  
 a) Time value of money, b) Financial leverage, c) ABC Analysis d) Net Present Value (2×4=8)
4. (a) What do you mean by the term Economic Order Quantity?  
 (b) A daily demand for an article is 50 units. Cost per order is Rs.25. Carrying cost per day per unit is Rs. 2. Lead time 15 days. Calculate (i) Economic Order Quantity (ii)  
 Re-order point. (3+5+2=10)
5. PVZ Petrochemicals company Ltd. is producing 72,000 units per annum .The cost structure and selling price per unit are given below:

Material	5.00
Labour	3.00
Overhead	<u>2.00</u>
Total cost	10.00
Profit	<u>5.00</u>
Selling Price	15.00

The other details in respect of operation of the company are:

(a) Raw material storage period: 3 months,(b)Work-in-progress period: 1 month,(c) Finished goods in store: 2 months, (d) Credit allowed to debtors: 1.5 months e) Credit allowed by creditors : 1month (f) Lag in payment of Overhead: 0.5 month.

25% of sales are made against cash.

Prepare a working capital requirement statement for a year. (10)

6. Jyoti Chemicals Ltd. is currently operating at 50% capacity and produces 10,000 units at a cost of Rs.180 per unit, the details of which are as follows:

	Rs.
Materials per unit	100
Wages per unit	30
Factory Overhead (40% fixed) per unit	30
Administrative overhead (50% variable) per unit	20
Current Selling Price	200

At 60% capacity, the materials' cost per unit increases by 2% and the selling price per unit fall by 2%. At 80% capacity the materials' cost per unit increases by 5% and the selling price per unit falls by 5%. Prepare a cost statement and profit at 50 %, 60% and 80 % capacity of production. Also give your comments on the profitability of the different production levels. (10)

✓ 7. Following are the details of two mutually exclusive project proposal of a company:

Project Cost	Project E (Rs.in Lakh)	Project F (Rs.in Lakh)
Cash Inflows:	1600	1600
Year 1	400	800
Year 2	200	600
Year 3	600	400
Year 4	900	200
Year 5	1200	200

Assume no residual values at the end of the year. The company's cost of capital is 10%. Calculate Net Present Value and discounted Pay Back Period (PBP) using a 10% discounting rate and select the most profitable project. (5+5=10)

- ✓ 8. a) Discuss the control of monopoly through (i) Lump Sum Tax (ii) Specific Tax.  
b) Distinguish between monopolistic competition and monopoly.  
c) Define perfect competition. (5+3+2=10)

- ✓ 9. a) Discuss the different types of price discrimination.  
b) Explain equilibrium price and output determination under discriminating monopoly.

- ✓ 10. a) Define selling cost.  
b) Analyze the long-run equilibrium of firm under monopolistic competition.  
c) Find the profit maximizing levels of output, prices and profit of a monopolist who is facing the demand functions  $X = -0.4P_x + 40$  and  $Y = 56 - P_y$  and cost function  $C = 3X^2 + 3Y^2 + 3XY + 33$ . (4+6=10)

- ✓ 11. a) Discuss the price-output determination under price leadership by the dominant firm.  
b) A monopolist faces the demand curve given by  $P = 20 - Q$  and his cost function is given as  $C = Q^2 + 8Q + 2$ . Determine the profit maximizing price and output.  
c) Distinguish between pure oligopoly and imperfect oligopoly. (4+4+2=10)

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Enrollment No. [ ]

S<sub>4</sub>(UBE04B05)BE

B.Tech 4<sup>th</sup> Semester End Term Examination, 2019  
Microbial Molecular Biology and Genetics

Paper Code: UBE04B05

Full Marks: 100

Time: 3 hours

The figures in the margin indicate full marks for the questions

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

I. Answer the following question.

2x10=20

1. The protein content and enzyme activity of a preparation changes during purification according to the following table. Calculate the changes in specific activity (which reflects the extent of purification) and the yield during the purification. Fill out the table with the missing data. Mention units for each data.

Purification step	Protein (mg)	Volume (ml)	Enzyme units (calculated based on activity)	Concentration	Specific activity	Yield	Fold Purification
Tissue extract	20000	2000	4000000			100 %	
NH <sub>4</sub> SO <sub>4</sub> precipitate	5000	200	3000000				
Ion exchange chromatography	1500	150	1000000				
Gel filtration	500	200	750000				
Affinity chromatography	45	20	675000				

2. Briefly describe the lac operon and how it controls the metabolism of lactose.

II. Answer the following question.

2.5x4=10

1. Give brief definitions or unique descriptions of the following terms: (Any four)  
(a) Size exclusion Chromatography, (b) Watson and Crick's structure of DNA (c) Microbial fermentation, (d) Ribosome, (e) chromosomal mutations

2. Distinguish clearly between the following pairs of items (Any Four).

2.5x4=10

1. Telomerase and Topoisomerase.

2. Prokaryotic and eukaryotic ribosome.

3. Prokaryotic and eukaryotic translation.

4. Microbial respiration and fermentation.

5. Missense mutation and nonsense mutation.

III. Answer the following question.

2x5=10

1. The doubling time of an infectious microbe is 20 minutes. How long will it take for the cell population to expand 1000-fold?

If our DNA contained combinations of three bases instead of four, how many amino acids could be encoded when a codon contains one, two, or three bases?

**IV. Answer the following question.**

$3 \times 10 = 30$

1. How do tRNA, rRNA, and mRNA differ in function?
2. What are the differences among a promoter sequence, termination sequence, and release factor?
3. You want to express a human keratin protein, so you need to integrate the human gene into a bacterial plasmid. If you cut out the human keratin gene directly from the human DNA genome and insert it into the plasmid, will the bacteria be able to express this gene for you? If not, why not? What additional steps would you need to do to get the bacteria to express your gene?
4. List the sequence of events that takes place when a DNA message is translated into protein.
5. Provide two examples of how a cell uses transcription to control gene expression.
6. Provide an example of why it is advantageous for a cell to control gene expression.
7. Both chromosomal and point mutations occur in DNA. In what ways do they differ?
8. What is a silent mutation? Provide an example.
9. Missense point mutations are isolated in the genes for E. coli RNA polymerase core subunits much more frequently than frameshift mutations. Why do you think this is?
10. Identify each of the following as either anabolic or catabolic:  
(a) Glycolysis      (b) synthesis of ATP      (c) photosynthesis      (d) protein synthesis  
(e) cellular respiration      (f) fermentation

**V. Multiple Choice Questions. Please record your answers on examination answer script.**

$20 \times 1 = 20$

1. The enzyme responsible for forming the final phosphodiester bond between two DNA fragments during DNA replication is  
a. DNA ligase      b. DNA polymerase I      c. DNA polymerase III      d. DNA-directed RNA polymerase  
e. reverse transcriptase
2. Which of the following helps to stabilize mRNA by inhibiting its degradation?  
a. TATA box      b. spliceosomes      c. exons      d. snRNPs      e. poly(A) tail
3. Which of the following is the best method for determining the three-dimensional structure of protein?  
a. Dialysis,      b. Electrophoresis,      c. X-ray diffraction,      d. Ultracentrifugation  
e. None of these
4. DNA damage by ultraviolet light is due to  
a. alkylation of the guanine in DNA,      b. excessive unwinding of the DNA molecule  
c. frequent replacement in the DNA molecule of purines by pyrimidines.  
d. induction of dimerization by way of covalent bonds between adjacent thymine groups.
5. Each of the following is involved in gene cloning EXCEPT one. Which one is this EXCEPTION?  
a. DNA ligase,      b. RNA polymerase,      c. DNA polymerase I,      d. Restriction nucleases  
e. Reverse transcriptase
6. As DNA is denatured, each of the following events take place EXCEPT one. Which event is this EXCEPTION?  
a. Total G-C content of total DNA increasing      b. UV light absorption increasing  
c. Complementary strands becoming random coils,      d. Base stacking becoming disrupted  
e. Hydrogen bond breaking
7. Which of the following enzymes or processes ensures that the correct amino acid is incorporated for a particular codon during protein synthesis?  
a. Amino Acyl-tRNA synthetase,      b. Ribosomal protein synthesis,      c. Post-transcription splicing  
d. RNA synthetase,      e. Helicase

8. Streptomycin is an antibiotic which inhibits the process of  
a. translation in eukaryotes., b. translation in prokaryotes., c. transcription in eukaryotes.  
d. transcription in prokaryotes., e. DNA replication in prokaryotes.

9. The termination of synthesis of a polypeptide is believed to involve  
a. nonsense codons., b. anticodon-codon interaction., c. tRNA which cannot bind amino acids.,  
d. hydrolysis of messenger RNA., e. none of the above.

10. In prokaryotic protein synthesis, the elongation factor G serves to

- a. form the initiation complex., b. facilitate the binding of Fmet tRNA.
- c. translocate the growing peptide chain and to move the ribosome along the mRNA.
- d. prevent the larger ribosomal subunits from binding with those that are smaller.

11. In a mixture of the five proteins listed below, which should elute second in size-exclusion (gel filtration) chromatography?

- |                               |                                  |
|-------------------------------|----------------------------------|
| a. cytochrome c Mr = 13,000   | b. immunoglobulin G Mr = 145,000 |
| c. ribonuclease A Mr = 13,700 | d. RNA polymerase Mr = 450,000   |
| e. serum albumin Mr = 68,500  |                                  |

12. What structure(s) are active in the uptake of nutrients?

- a. porins b. transport proteins c. lipid A d. peptidoglycan

13. Cell constituents (nucleic acids, proteins, lipids) are made in proportion to one another in the \_\_\_\_\_ phase of growth in batch culture

- a. death b. stationary c. exponential d. lag

14. Production of antibiotics is most likely to take place in the \_\_\_\_\_ phase

- a. death b. stationary c. exponential d. lag

15. Which of the following separation method is suited method for a protein sample with large differences in molecular mass

- a. dialysis b. salting out process c. density gradient centrifugation d. rate zonal centrifugation

16. Chromatography is based on the

- a. Different rate of movement of the solute in a column
- b. Separation of one solute from other constituents by being captured on the adsorbent
- c. Different rate of movement of the solvent in the column
- d. None of the above

17. Ion exchange chromatography is based on the

- a. Electrostatic attraction b. Electrical mobility of ionic species
- c. Adsorption chromatography d. Partition chromatography

18. The elements responsible for directing RNA polymerase to a particular gene to begin transcription include

- a. initiation factors and rho
- b. promoter, sigma factor, and rho
- c. promoter, sigma factors, and elongation factors
- d. promoter and initiation factors
- e. promoter and sigma factors

19. More than one codon can specify the amino acid serine because

- a. there is more than one tRNA type that carry serine and that have different anticodons
- b. the serine tRNA may wobble when binding to a codon and therefore recognize more than one codon
- c. there is more than one serine tRNA synthetase to put serine on different tRNAs
- d. a and b
- e. all of the above

20. Tetracycline inhibits binding of charged tRNAs to bacterial ribosomes, except fmet-tRNA. The most likely target of tetracycline is:

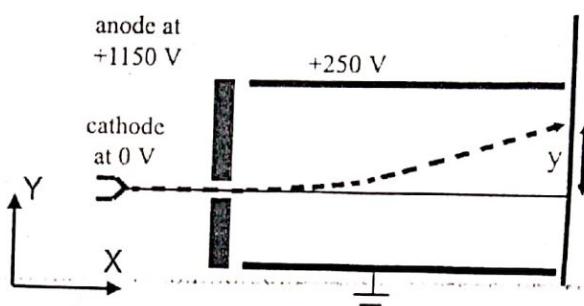
- a. the anticodons
- b. the ribosome binding site
- c. aminoacyl tRNA synthetases
- d. the A site of the ribosome
- e. the ribosomal RNA (rRNA)

You may use the following chart:

	U	C	A	G	
U	UUU phe	UCU ser	UAU tyr	UGU cys	U
	UUC phe	UCC ser	UAC tyr	UGC cys	C
	UUA leu	UCA ser	UAA STOP	UGA STOP	A
	UUG leu	UCG ser	UAG STOP	UGG trp	G
C	CUU leu	CCU pro	CAU his	CGU arg	U
	CUC leu	CCC pro	CAC his	CGC arg	C
	CUA leu	CCA pro	CAA gln	CGA arg	A
	CUG leu	CCG pro	CAG gln	CGG arg	G
A	AUU ile	ACU thr	AAU asn	AGU ser	U
	AUC ile	ACC thr	AAC asn	AGC ser	C
	AUA ile	ACA thr	AAA lys	AGA arg	A
	AUG met	ACG thr	AAG lys	AGG arg	G
G	GUU val	GCU ala	GAU asp	GGU gly	U
	GUC val	GCC ala	GAC asp	GGC gly	C
	GUA val	GCA ala	GAA glu	GGA gly	A
	GUG val	GCG ala	GAG glu	GGG gly	G

## I. Answer the following questions. (Any Two) (10 marks each)

1. Electrons (mass  $9.1 \times 10^{-31}$  kg) are emitted from the cathode in an evacuated tube. The electrons start from rest and are accelerated through a potential difference of 1150V. Some of the electrons pass through the anode into a region where the electric field is perpendicular to their velocity as shown below.



Calculate:

- a) The speed of the electrons when they arrive at the anode?

- b) The deflection  $y$  that they undergo after passing between two parallel plates which are  $2 \times 10^{-2}$  m long and  $1 \times 10^{-2}$  m apart, and between which a potential difference of 250V is maintained.

- ✓ 2. An electron of mass  $m$  travelling with speed  $u$  collides with an atom and its speed is reduced to  $v$ . The speed of the atom is unaltered, but one of its electrons is excited to a higher energy level and then returns to its original state, emitting a photon of light. Show that the frequency of this photon is given by

$$\frac{m(u^2 - v^2)}{2h}$$

- ✓ 3. A slide of a sample is placed 12mm from the objective lens of a microscope. The focal length of the objective lens is 10.0 mm. (a) How far from the lens is the image formed? (b) What is the magnification of this image? (c) The real image formed is located 10 mm beneath the microscope eyepiece lens. If the focal length of the eye piece is 20 mm, where does the final image appear?

## II. Answer the following questions briefly. (any ten) (3 marks each)

- ✓ 1. Compare the processes (photoelectric effect, Compton effect, Rayleigh scattering, pair production) by which photons interact with matter.
2. An electron with energy  $-5 \times 10^{-19}$  J moves around an atomic nucleus in a circular orbit. a) What is its wavelength, and b) what is the radius of the orbit into which just two wavelengths fit?
3. Distinguish clearly between the following. (any two)
- Scanning Electron Microscope and Transmission Electron Microscope.
  - Phase Contrast Microscope and Differential - Interference Microscope.
  - Reflection versus Scattering
4. Write in brief on following.
- Spin-lattice/Longitudinal relaxation
  - Spin-spin/Transverse relaxation

- ✓ 5. A radioactive isotope decays by alpha and  $\beta^-$  particle emission. Over a number of decays the nucleon number decreases by 4 while the proton number is unchanged. How many alpha and  $\beta^-$  particles have been emitted?
- ✓ 6. a) Light of wavelength 500nm incident on a metal surface ejects electrons with kinetic energies up to a maximum value of  $2 \times 10^{-19}$  J. What is the energy required to remove an electron from the metal in eV?  
b) If a beam of light causes no electrons to be ejected, however great its intensity, what can be said about its wavelength?
- ✓ 7. What is the Larmor frequency? Does the Larmor frequency depend on the static external magnetic field?
- ✓ 8. The iron isotope  $^{56}\text{Fe}$  is near the peak of the stability curve. This is why iron is generally prominent in the spectrum of the Sun and stars. Show that  $^{56}\text{Fe}$  has a higher binding energy per nucleon than its neighbors  $^{55}\text{Mn}$  and  $^{59}\text{Co}$ .  
( $^{56}\text{Fe}$  Z= 26, M in amu = 55.934942,  $^{55}\text{Mn}$  Z= 25, M in amu = 54.938050,  $^{59}\text{Co}$  Z= 27, M in amu = 58.933200)
- ✓ 9. Two protons are held at rest a distance of  $1\text{fm} = 10^{-15}\text{ m}$  apart. What is the speed of one of the protons (in m/s) a long time after they are released?
- ✓ 10. Light is said to have a dual wave-particle nature. What does this statement mean? Describe the difference between a quantum and a photon.
- ✓ 11. The maximum lateral (xy) resolution of a light microscope is approximately  $0.2\mu\text{m}$ . What parameters determine this resolution?

**III. Mark the correct answer only- (1 mark each):**

**10x1= 10**

- One of the particles expected to be discovered at the Superconducting Super Collider is the:  
a. Higg's boson,      b. tau meson,      c. tachyon.      d. anti-proton.
- An object is located 1 meter in front of a converging lens having a focal length of 20 centimeters. At what distance behind the lens (whose thickness is negligible) will the image be formed?  
a. 18 centimeters      b. 20 centimeters      c. 22 centimeters      d. 25 centimeters
- Photoelectric electricity is produced directly from solar energy when which of the following are absorbed in a semiconductor to create an electric current?  
a. protons      b. electrons      c. neutrons      d. photons
- Of the following, the most energetic form of NON-IONIZING radiation is:  
a. ultra-violet light      b. infra-red light      c. radar      d. microwaves
- For which of the following reasons is plutonium-238 used for generating electricity on spacecraft?  
a. It is an alpha emitter with long half-life.  
b. It is a beta emitter with high specific power. y) It occurs abundantly in nature.  
c. It has low specific power.
- What is the DeBroglie wavelength of a 1,200 kilogram corvette traveling at a rate of 25 meters per second?  
Planck's constant is equal to  $6.62 \times 10^{-34}$  Joule-seconds.  
a.  $5.3 \times 10^{-32}$  meters      b.  $5.9 \times 10^{-34}$  meters      c.  $2.1 \times 10^{-38}$  meters      d.  $1.6 \times 10^{-40}$  meters
- What is required for a nuclear transmutation to occur?  
a. a corrosive environment      b. a particle to collide with a nucleus  
c. gamma emission      d. spontaneous nuclear decay  
e. very high temperature
- A high-powered microscope that produces an image from scattered secondary electrons is the  
a. immunofluorescence microscope.      b. bright-field light microscope.  
c. transmission electron microscope (TEM). d. scanning electron microscope (SEM).
- The fundamental resolution of an optical instrument is set by

- a. the accuracy to which lenses can be polished.
  - b. the fact that white light is composed of all visible colors.
  - c. the fact that all types of glass have nearly the same index of refraction.
  - d. the wave nature of light.
10. The magnification of a microscope is increased when
- a. the focal length of the objective lens is increased.
  - b. the focal length of the objective lens is decreased.
  - c. the focal length of the eyepiece is increased.
  - d. the distance between the objective lens and eyepiece is decreased.

5x6=30

**IV. Answer the following questions briefly. (6 marks each)**

- ✓ 1. Electrons are drawn out from cathode by applying the high voltage ( $3 \times 10^4$  V) between two metallic electrodes installed in the tube in vacuum. Calculate the speed of electron before it collides to the anode plate.
- ✓ 2. A sodium surface is illuminated with light of wavelength 0.300 μm. The work function for sodium is 2.46 eV. (a) Calculate the energy of each photon in electron volts, (b) the maximum kinetic energy of the ejected photoelectrons, and (c) the cutoff wavelength for sodium.
3. The linear attenuation coefficient for 2.0-MeV gamma rays in water is  $4.9 \text{ m}^{-1}$ . (a) Find the relative intensity of a beam of 2.0-MeV gamma rays after it has passed through 10 cm of water. (b) How far must such a beam travel in water before its intensity is reduced to 1 percent of its original value?
- ✓ 4. A measurement establishes the position of a proton with an accuracy of  $\pm 1.00 \times 10^{-11} \text{ m}$ . Find the uncertainty in the proton's position 1.00 s later. Assume  $v \ll c$ .
- ✓ 5. When measuring the X-ray diffraction pattern of potassium chloride (KCl) powder sample by Cu-K<sub>α</sub> radiation, ( $\lambda = 0.1542 \text{ nm}$ ), diffraction peaks appeared with the scattering angle ( $2\theta = 24.48^\circ$ ), Miller indices of (111). Calculate the unit cell dimension of the cubic potassium chloride crystal.

Equations and conversion factors that may be useful:

$$x = x_0 + v_0 t + \frac{1}{2} a_t t^2 \quad v_f = v_0 + at \quad v_f^2 = v_0^2 + 2ax \quad F = ma \quad F_g = G \frac{m_1 m_2}{d^2}$$

$$1 \text{ m} = 3.28 \text{ ft.} \quad 1 \text{ mi} = 1.61 \text{ km} \quad 1 \text{ m/s} = 2.24 \text{ mi/h} \quad 1 \text{ lb.} = 4.45 \text{ N} \quad c = 3.00 \times 10^8 \text{ m/s}$$

$$M_{\text{Earth}} = 5.98 \times 10^{24} \text{ kg} \quad R_{\text{Earth}} = 6.38 \times 10^6 \text{ m} \quad G = 6.67 \times 10^{-11} \text{ N} \cdot \text{m}^2/\text{kg}^2 \quad g = 9.80 \text{ m/s}^2$$

$$\gamma = 1/\sqrt{1 - v^2/c^2} \quad t = t_0 \gamma \quad L = L_0 / \gamma \quad m = m_0 \gamma \quad p = m_0 v \gamma \quad E = m_0 c^2 \gamma$$

$$E = hf \quad p = E/c \quad \lambda = h/p \quad \Delta p, \Delta x \geq h/2\pi \quad \Delta E \Delta t \geq h/2\pi \quad h = 6.63 \times 10^{-34} \text{ J} \cdot \text{s}$$

$$E_n = -\frac{ke^2 Z^2}{2a_0 n^2} \quad r_n = n^2 \frac{a_0}{Z} \quad a_0 = 5.29 \times 10^{-11} \text{ m} \quad L = \sqrt{l(l+1)} \frac{h}{2\pi} \quad L_z = m_l \frac{h}{2\pi}$$

$$r = (1.2 \times 10^{-15} \text{ m}) A^{1/3} \quad N = N_0 e^{-\lambda t} \quad t_{1/2} = \frac{\ln 2}{\lambda} \quad u = 1.660540 \times 10^{-27} \text{ kg} \quad 1 \text{ G} = 10^{-4} \text{ T}$$

$$\epsilon_0 = 8.85 \times 10^{-12} \text{ C}^2/(\text{N} \cdot \text{m}^2) \quad \mu_0 = 4\pi \times 10^{-7} \text{ T} \cdot \text{m/A} \quad m_p = 1.67 \times 10^{-27} \text{ kg}$$

$$e = 1.602 \times 10^{-19} \text{ C} \quad k = \frac{1}{4\pi\epsilon_0} = 8.99 \times 10^9 \text{ N} \cdot \text{m}^2/\text{C}^2 \quad m_e = 9.11 \times 10^{-31} \text{ kg}$$

$$\Delta x \Delta p \approx h/m, \quad m_p = 1.007277 \text{ amu}, \quad m_n = 1.008665 \text{ amu}, \quad m_e = 0.000549 \text{ amu}$$