B.Sc. ZOOLOGY

SEMESTER - VI
Paper – VII, DSC – II
Immunology and Animal Biotechnology
Practical Question Paper

Max. Marks: 25
2hrs

I. Identification, labeled diagram and salient features of spots **3x2 = 06**

1. A) Spleen B) Thymus C) Lymph nodes
2. A) SLE B) Rheumatoid arthritis C) Chronic thyroiditis (CT)
3. A) Plasmids B) Cosmids C) Transgenic animlas

II. Identification/Determination from Immunology **6 Marks**

1) Identification of your own blood group (slide method)
2) Enumeration of RBC/TEC from a given blood sample
3) Enumeration of WBC/WBC count from a given blood sample
4) Enumeration of differential count of WBC from a given blood sample

III. Identification/study the technique from Animal Biotechnology (through photographs) **6 Marks**

A) Southern blotting B) Western blotting
C) DNA sequencing D) DNA finger printing

IV. Project work--**2 Marks**

V. Record work--**3 Marks**

VI. Viva---**2 Marks**

B.Sc.(CBCS) ELECTRONICs III YR, VI – SEMESTER QUESTION BANK FOR PRACTICAL EXAMS

Practicals Paper – VII : DIGITAL COMMUNICATION LAB

I. Experiments in Internetworking:

1) Testing of RJ-45 Cable (Straight/ Cross)

2) Introduction to LAN cable and Hub.

3) Verifying physical and logical address.

4) Sending data/ Data transfer from system to system.

5) Concept of HTTP.

6) File transfer FTP.

7) Introduction to server and client.

8) Introduction to network IP address.

9) Identification of NET ID using masks.

10) Mail transfer using SMTP.

11) Encryption (plain text to Hypertext).

12) Study of Router configuration.

13) Study of two networks between LAN and LAN/ MAN and MAN/ WAN and WAN.

14) Introduction to network devices.

15) Static Routing.

16) Basic RIP (observe RIP routers and understand the commands)

17) RIP V2.

18) OSPF (Open Shortest Path First)

II Experiments in Data Communication.

1) Study of serial communication.

2) Study of protocol in communications.

3) Study of Fiber optic communications.

4) Study of wireless communications.

5) Study of parallel communication.

B.Sc.(CBCS) ELECTRONICs III YR, VI – SEMESTER QUESTION BANK FOR PRACTICAL EXAMS

Practicals (Elective) Paper – VIII-A : 8051 MICROCONTROLLER AND APPLICATIONS LAB

Experiments using 8051 microcontroller:

1. Multiplication of two numbers using MUL command (later using counter method for repeated addition).

2. Division of two numbers using DIV command (later using counter method for repeated subtraction).

3. Pick out the largest/smallest number among a given set of numbers.

4. Arrange the given numbers in ascending/descending order.

5. Generate a specific time delay using timer/counter.

6. Interface ADC and a temperature sensor to measure temperature.

7. Interface DAC and generate a staircase wave form with a step duration and number of steps as variables.

8. Flash a LED connected at a specified out port terminal.

9. Interface stepper motor to rotate clock wise / anti clock wise through a given angle steps.

Experiments with Keil Software:

1. Write a program to pick out largest/smallest number among a given set of number.

2. Write a program to arrange a given set of numbers in ascending/descending order.

3. Write a program to generate a rectangular/square wave form at specified port.

4. Write a program to generate a time delay using timer registers.

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Practicals (Elective) DSE: Paper – VIII-B : VHDL - LAB

VHDL – Program entry, simulation and Implementation (CPLD/FPGA) using appropriate HDL Software for the following circuits.

1. All types of logic gates (Data flow).

2. Half Adder (Data Flow, Structural and Schematic).

3. Full Adder (Data Flow, structural and Schematic).

4. Half Subtractor (Data Flow, Structural and Schematic).

5. Full Subtractor (Data Flow, Structural and Schematic).

6. Two control input Mux. Using case.

7. Two control input Mux. Using conditional signal assignment.

8. Two control input Mux. Using selected signal assignment.

9. Two control input Demux. Using case.

10. BCD to seven segment decoder.

11. Modeling a RSFF with assertion, report and different levels of severity (Behavioral).

12. Modeling a BCD counter (Top level behavioral)

13. Writing a test bench for a Half adder.

14. Writing a test bench for a Full adder.

FACULTY OF SCIENCE
B.Sc. III Year (PRACTICAL) Examination
Subject: Microbiology
Paper-VII
QUESTION BANK

PAPER VII – Medical Microbiology

Time: 2 Hours **Max. Marks: 25**
Note: Each candidate has to perform one experiment and four spotters.

I. Experiment Questions (Marks= 12)

1. A clinical specimen collected from a patient (wound infection / throat infection / urine Infection)and culturedis provided to you. Identify the etiological agent by its microscopicand biochemicalreactions.
2. Determine the phenol coefficient of given test disinfectant.
3. Identify the pathogenic bacteria based on cultural characteristics on the given medium.
4. Determine the drug of choice for the given pathogen (provide 2 pathogens and minimum of 4 antibiotics for each organism).

II. Specimens for spotting (Marks 2x4= 8)

5. *Mycobacterium*
6. *Candida albicans*
7. *Entamoebahistolytica*
8. *Plasmodium*
9. Indole test
10. Simmon's citrate slants
11. Kovac's reagent with labeling
12. Ouchterlony double diffusion
13. *Pseudomonas*
14. *Klebsiella*

III. Record& viva(Marks= 5)

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FACULTY OF SCIENCE
B.Sc. III Year (PRACTICAL) Examination
Subject: Microbiology
Paper-VIII
QUESTION BANK

PAPER VIII – Food Microbiology

Time: 3 Hours **Max. Marks: 25**
Note: Each candidate has to perform one experiment and four spotters.

I. Experiment Questions (Marks= 12)

1. An industrial / sewage water sample is provided to you. Find out the amount of dissolved oxygen present in it and determine the BOD of the sample (required datafor BOD calculation to be provided by examiners).
2. Evaluate the bacteriological quality of the given milk sample by performing Methylene blue reduction test (MBRT) and explain your results (provide minimum of 3 different milk samples to each student).
3. A spoiled food sample by fungi is provided. Identify the fungal organisms by microscopic observation& report your result.
4. A spoiled food sample inoculated medium is provided. Identify thebacterial contaminants by microscopic observation& report your result.
5. A water sample was inoculated for presumptive coliform test and tubes with growth are provided. Find out the coliform count by MPN method and report your result.

II. Specimens for spotting (Marks 2x4= 8)

6. Spoiled bread
7. Spoiled fruit/ vegetable
8. *E.coli*
9. Curdling bacteria slide (Streptococci/Lactobacilli)
10. Crowded plate
11. *Azotobacter/Azospirillum* (slide)
12. Tubes of presumptive coliform test with MPN table
13. *Pencillium*
14. *Aspergillus*

III. Record& viva (Marks= 5)

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FACULTY OF SCIENCE
B.Sc. III Year (PRACTICAL) Examination
Subject: Microbiology
Paper-VIII
QUESTION BANK

PAPER VIII – Industrial Microbiology

Time: 3 Hours **Max. Marks: 25**

I. Experiment Questions **(Marks= 12)**

1. A sample of fermented broth is provided to you. Find out the quantity of alcohol present in it by colorimetricmethod and prepare your standard graph. Calculate the fermentation efficiency (other required data for calculation of yield to be provided by examiners).
2. A sample of alcoholic fermented broth is provided to you. Find out the amount of left over sugar present in it by colorimetric method and prepare your standard graph. Calculatethe fermentation efficiency (other required data for calculation of yield to be providedby examiner).
3. Fermented broth of citric acid is provided to you. Find out the amount of citric acid by titrimetry method & explain your results.
4. A source sample inoculated and grown on starch agar plates for amylolytic organisms is provided. Test for amylolytic activity by quantitative test& explain your results.
5.Find out the amount of streptomycin present in the given sample(unknown sample and necessaryreagents to be provided by examiner).

II. Specimens for spotting **(Marks 2x4= 8)**

6. Yeast (slide)
7. *Aspergillus*sp. (slide)
8. *Bacillus* sp. (slide)
9. *Lactobacillus* (slide)
10. *Pencillium* (slide)
11. Colorimetry
12. Starch agar plate with amylolytic activity

III. Record& viva (Marks= 5)

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B.SC.(CBCS) III YR, VI – SEMESTER QUESTION BANK FOR PRACTICAL EXAMS

Practicals Paper – VII :

Modern Physics

1. To determine the Planck's constant using LEDs of at least 4 different colors.
2. To determine the value of e/m by (a) Magnetic focusing or (b) Bar magnet.
3. To setup the Millikan oil drop apparatus and determine the charge of an electron.
4. To determine the wavelength of laser source using diffraction of single slit.
5. To determine (1) wavelength and (2) angular spread of He-Ne laser using plane diffraction grating
6. To determine the value of e/m for electron by long solenoid method.
7. To determination the Planck's constantby using Photo Cell.
8. To Measure the magnetic field – Hall probe method.
9. To determine the dead time of a given G.M. tube by using double source.
10. To determine the Absorption coefficients of a materialby using G. M. Counter.
11. To draw the plateau curve for a Geiger Muller counter.
12. To find the half-life period of a given radioactive substance using a G.M. Counter.

B.SC.(CBCS) III YR, VI – SEMESTER QUESTION BANK FOR PRACTICAL EXAMS

Practicals Paper – VIII A :

Basic Electronics

1. To verify the truth tables of AND, OR, NOT, gates
2. To construct and verify the truth tables of AND, OR, NOT gates using universal gates
3. To verify the truth tables of NAND and NOR gates
4. To study the Characteristics of a Transistor in CE configuration
5. To study the frequency response of R.C. coupled amplifier.
6. Verification of De Morgan's Theorem.
7. To study and draw the V-I characteristicsof Zener diode.
8. Verification Thevenin's theorem.
9. Maximum Power Transfer theorem
10. To study and draw the V-I characteristics of P-n junction diode.
11. Zener diode as a voltage regulator
12. Determine the output frequency of R C phase shift Oscillator.

B.SC.(CBCS) III YR, VI – SEMESTER QUESTION BANK FOR PRACTICAL EXAMS

Practicals Paper – VIII-B :

Physics of Semiconductor Devices

1. To study the Characteristics of a Transistor in CE configuration
2. To study and draw the V-I characteristics of Zener diode.
3. To study and draw the V-I characteristics P-N junction diode.
4. Zener diode as a voltage regulator
5. To Determine the carrier concentration using Hall effect
6. To study the characteristics of Thermistor
7. To determine the Efficiency of a LED
8. Solar cell: fill factor and efficiency
9. To study the Characteristics of FET.
10. To study the Characteristics of SCR.
11. To study the Characteristics of UJT.

B.SC.(CBCS) III YR, VI – SEMESTER QUESTION BANK FOR PRACTICAL EXAMS

Practicals Paper – VIII-B :

Physics of Semiconductor Devices

1. To study the Characteristics of a Transistor in CE configuration
2. To study and draw the V-I characteristics of Zener diode.
3. To study and draw the V-I characteristics P-N junction diode.
4. Zener diode as a voltage regulator
5. To Determine the carrier concentration using Hall effect
6. To study the characteristics of Thermistor
7. To determine the Efficiency of a LED
8. Solar cell: fill factor and efficiency
9. To study the Characteristics of FET.
10. To study the Characteristics of SCR.
11. To study the Characteristics of UJT.

B.Sc. III year
Semester VI
Elective Theory (A)
Animal Biotechnology Question Bank

Major questions:

1. Explain the procedure for preparation of different animal cell culture media. Perform sub-culturing of the given animal cell line.
2. Write the principle and procedure for isolation of cells from chicken liver. Isolate cells from the chicken liver provided to you.
3. Write the principle and procedure for isolation of cells from chick embryo. Isolate the different cell types from the given chick embryos.
4. Write the principle and procedure for establishment of primary cell culture from spleen.
5. Write the principle and procedure for establishment of primary cell culture from liver.
6. Explain the principle and procedure for *in vitro* preparation of somatic metaphase chromosomes.
7. Describe the principle and protocol for animal cloning.
8. Explain the principle and procedure for gene mapping using molecular markers.
9. Write the principle and procedure for gene transfer in animals.

Minor Questions:

1. Write the importance of various media components used in animal cell culture.
2. Explain the importance of bio safety cabinet, and CO2 incubator in animal cell culture.
3. Write the significance of trypsinization during sub-culturing of cells.
4. Explain the principle involved in the isolation of cells from chicken liver.
5. Explain the principle for isolation of cells from chick embryo.
6. Write the principle for establishment of primary cell cultures.
7. Write the principle for preparation of metaphase chromosomes.
8. Explain the principle behind animal cloning
9. Explain the importance of molecular markers in mapping.

Spotters:

1. Cell culture media
2. Bio-safety cabinet
3. Carbon-di-oxide incubator
4. T-flask
5. Tissue culture plates
6. Inverted microscope
7. Stem cells
8. Microinjection
9. Somatic cell nuclear transfer
10. RFLP markers
11. RAPD markers
12. Animal Cloning – Dolly
13. Gene therapy
14. Transgenic animals

B.Sc. III year
Semester VI
Core theory VI
Microbial Technology Question Bank

Major questions:

1. Write the principle and procedure for production of citric acid. Estimate the fermentation efficiency for the same.
2. Write the different methods employed for screening for amylase producing microorganisms.
3. Describe the principle and steps involved in the production of wine using common yeast. Calculate the fermentation efficiency.
4. Explain the principle and procedure for production of alcohol by fermentation.
5. Write the principle and procedure for estimation of alcohol using colorimetry. Estimate the amount of alcohol in the given sample and report the result.
6. Write the principle and procedure for production of biogas from cow dung.
7. Describe the principle and procedure for production of Penicillin/Ampicillin. Add a note on the determination of antibiotic sensitivity.
8. Explain the principle and procedure for production of biofertilizers from Azolla sps.
9. Write the detailed procedure for estimation of dissolved oxygen in water samples. Estimate the amount of dissolved oxygen in the given water sample.
10. Write the detailed procedure for the isolation of microbes from soil.
11. Write the detailed procedure for the isolation of microbes from industrial effluents.
12. Write the principle and procedure for the testing of milk by MBRT. Detect the quality of the given milk sample and report the result.

Minor Questions:

1. Write the techniques used for primary screening of microorganisms.
2. Write the techniques used for secondary screening of microorganisms.
3. Write the principle for production of citric acid using Aspergillus.
4. Calculate the fermentation efficiency for production of citric acid.
5. Write the principle for production wine using common yeast.
6. Explain the principle for production of alcohol by fermentation.
7. Write the principle for alcohol estimation by colorimetry.
8. Write the principle for production of biogas from cattle dung.
9. Write the principle for antibiotic production using micrororganisms.
10. Explain the principle for production of biofertilizers using Azolla.
11. Write the principle for estimation of dissolved oxygen in water samples.
12. Explain the principles for isolation of microorganisms from soil and industrial effluents.
13. Write the principle for milk testing using methylene blue.

Spotters:

1. Fermentor – identifying the components [sparger, baffles, impeller, inlet, outlet etc.]
2. Batch and continuous fermentor
3. Aspergillus – importance
4. Yeast
5. Zone of inhibition for antibiotics
6. Amylase production-starch test

B.Sc Practical Examinations

Semester: VI

Subject: Environmental Biotechnology and Biodiversity

Question Bank

1. Write the principle involved in Biological oxygen demand estimation. Estimate the BOD in the given waste water sample along with control. (Major Experiment)
2. Write the principle involved in Biological oxygen demand estimation. Estimate the BOD in the given industrial effluent sample along with control. (Major Experiment)
3. Write the principle involved in Chemical oxygen demand estimation. Estimate the COD in the given waste water sample along with control. (Major Experiment)
4. Write the principle involved in Chemical oxygen demand estimation. Estimate the COD in the given waste water sample along with control. (Major Experiment)
5. Write the procedure and perform determination of dissolved solids in the given waste water sample along with control. (Minor Experiment)
6. Write the procedure and determine dissolved solids in the given industrial effluent sample along with control. (Minor Experiment)
7. What is the principle involved and procedure for isolation of microorganisms from contaminated soil? (Minor Experiment)
8. What is the principle involved and procedure for isolation of microorganisms from industrial effluent sample? (Minor Experiment)
9. Write the procedure for the estimation of Coliforms in the given waste water sample. (Minor Experiment)
10. Write the principle for the production of hydrogen gas from cow dung. Estimate the amount of hydrogen gas produced from the given cow dung sample along with controls. (Major Experiment)
11. **Spotters** –
    i) Air/water/land pollution
    ii) Municipal waste
    iii) Industrial effluent
    iv) Algal blooms
    v) Green house effect
    vi) Plant biomass
    vii) Microbial biomass
    viii) Organic composting
    ix) Phytoremediation
    x) Biodiversity conservation

2.18.1 Practicals Question Bank

Numerical Analysis

Unit-I

1. Use the Bisection method to find p_3 for $f(x) = \sqrt{x} - \cos x$ on $[0, 1]$.

2. Let $f(x) = 3(x+1)(x - \frac{1}{2})(x-1)$.Use the Bisection method on the following intervals to find p_3.

   a. $[-2, 1.5]$ b. $[-1.25, 2.5]$

3. Use the Bisection method to find solutions accurate to within 10^{-5} for the following problems.

   a. $x - 2^{-x} = 0$ for $0 \le x \le 1$

   b. $e^x - x^2 + 3x - 2 = 0$ for $0 \le x \le 1$

   c. $2x\cos(2x) - (x+1)^2 = 0$ for $-3 \le x \le -2$ and $-1 \le x \le 0$

4. Use algebraic manipulation to show that each of the following functions has a fixed point at p precisely when $f(p) = 0$, where $f(x) = x^4 + 2x^2 - x - 3$.

   a. $g_1(x) = (3 + x - 2x^2)^{1/4}$ b. $g_2(x) = \left(\frac{x+3-x^4}{2}\right)^{1/2}$

5. Use a fixed-point iteration method to determine a solution accurate to within 10^{-2} for $x^4 - 3x^2 - 3 = 0$ on $[1, 2]$. Use $p_0 = 1$.

6. Use a fixed-point iteration method to determine a solution accurate to within 10^{-2} for $x^3 - x - 1 = 0$ on $[1, 2]$. Use $p_0 = 1$.

7. Use a fixed-point iteration method to find an approximation to $\sqrt{3}$ that is accurate to within 10^{-4}.

8. The equation $x^2 - 10\cos x = 0$ has two solutions, ± 1.3793646. Use Newton's method to approximate the solutions to within 10^{-5} with the following values of p_0.

   a. $p_0 = -100$ b. $p_0 = -50$ c. $p_0 = -25$

   d. $p_0 = 25$ e. $p_0 = 50$ f. $p_0 = 100$

9. The equation $4x^2 - e^x - e^{-x} = 0$ has two positive solutions x_1 and x_2. Use Newton's method to approximate the solution to within 10^{-5} with the following values of p_0.

   a. $p_0 = -10$ b. $p_0 = -5$ c. $p_0 = -3$

   d. $p_0 = -1$ e. $p_0 = 0$ f. $p_0 = 1$

g. $p_0 = 3$ **h.** $p_0 = 5$ **i.** $p_0 = 10$

10. Use each of the following methods to find a solution in $[0.1, 1]$ accurate to within 10^{-4} for

$$600x^4 - 550x^3 + 200x^2 - 20x - 1 = 0.$$

a. Bisection method **b.** Newton's method **c.** Secant method

d. method of False Position **e.** Müller's method

Unit-II

11. For the given functions $f(x)$, let $x_0 = 0, x_1 = 0.6$, and $x_2 = 0.9$. Construct interpolation polynomials of degree at most one and at most two to approximate $f(0.45)$, and find the absolute error.

a. $f(x) = \cos x$ **b.** $f(x) = \ln(x+1)$

12. For the given functions $f(x)$, let $x_0 = 1, x_1 = 1.25$, and $x_2 = 1.6$. Construct interpolation polynomials of degree at most one and at most two to approximate $f(1.4)$, and find the absolute error.

a. $f(x) = \sin \pi x$ **b.** $f(x) = \log_{10}(3x - 1)$

13. Let $P_3(x)$ be the interpolating polynomial for the data $(0,0), (0.5, y), (1,3)$, and $(2,2)$. The coefficient of x^3 in $P_3(x)$ is 6. Find y.

14. Neville's method is used to approximate $f(0.4)$, giving the following table.

$x_0 = 0$	$P_0 = 1$			
$x_1 = 0.25$	$P_1 = 2$	$P_{01} = 2.6$		
$x_2 = 0.5$	P_2	$P_{1,2}$	$P_{0,1,2}$	
$x_3 = 0.75$	$P_3 = 8$	$P_{2,3} = 2.4$	$P_{1,2,3} = 2.96$	$P_{0,1,2,3} = 3.016$

Determine $P_2 = f(0.5)$.

15. Neville's method is used to approximate $f(0.5)$, giving the following table.

$x_0 = 0$	$P_0 = 0$		
$x_1 = 0.4$	$P_1 = 2.8$	$P_{0,1} = 3.5$	
$x_2 = 0.7$	P_2	$P_{1,2}$	$P_{0,1,2} = \frac{27}{7}$

Determine $P_2 = f(0.7)$.

16. Neville's Algorithm is used to approximate $f(0)$ using $f(-2), f(-1), f(1)$ and $f(2)$. Suppose $f(-1)$ was overstated by 2 and $f(1)$ was understated by 3. Determine the error in the original calculation of the value of the interpolating polynomial to approximate $f(0)$.

17. Use the Newton forward-difference formula to construct interpolating polynomials of degree one, two, and three for the following data. Approximate the specified value using each of the polynomials.

a. $f(0.43)$ if $f(0) = 1, f(0.25) = 1.64872, f(0.5) = 2.71828, f(0.75) = 4.48169$

b. $f(0.18)$ if $f(0.1) = -0.29004986, f(0.2) = -0.56079734, f(0.3) = -0.81401972, f(0.4) = -1.0526302$

18. Use the Newton backward-difference formula to construct interpolating polynomials of degree one, two, and three for the following data. Approximate the specified value using each of the polynomials.

a. $f(0.43)$ if $f(0) = 1, f(0.25) = 1.64872, f(0.5) = 2.71828, f(0.75) = 4.48169$

b. $f(0.25)$ if $f(-1) = 0.86199480, f(-0.5) = 0.95802009, f(0) = 1.0986123, f(0.5) = 1.2943767$

19. Determine the natural cubic spline S that interpolates the data $f(0) = 0, f(1) = 1$, and $f(2) = 2$.

20. Determine the clamped cubic spline S that interpolates the data $f(0) = 0, f(1) = 1, f(2) = 2$ and satisfies $s'(0) = s'(2) = 1$.

Unit-III

21. Use the forward-difference formulas and backward-difference formulas to determine each missing entry in the following tables.

a.

x	$f(x)$	$f'(x)$
0.5	0.4794	
0.6	0.5646	
0.7	0.6442	

b.

x	$f(x)$	$f'(x)$
0.0	0.00000	
0.2	0.74140	
0.4	1.3718	

22. Derive a method for approximating $f'''(x_0)$ whose error term is of order h^2 by expanding the function f in a fourth Taylor polynomial about x_0 and evaluating at $x_0 \pm h$ and $x_0 \pm 2h$.

23. The forward-difference formula can be expressed as

$$f'(x_0) = \frac{1}{h}[f(x_0 + h) - f(x_0)] - \frac{h}{2}f''(x_0) - \frac{h^2}{6}f'''(x_0) + O(h^3).$$

Use extrapolation to derive an $O(h^3)$ formula for $f'(x_0)$.

24. Show that

$$\lim_{h \to 0} \left(\frac{2+h}{2-h}\right)^{1/h} = e.$$

25. Approximate the following integrals using the Trapezoidal rule.

a. $\int_{0.5}^{1} x^4 dx$

b. $\int_0^{0.5} \frac{2}{x-4} dx$

c. $\int_1^{1.5} x^2 \ln x dx$

d. $\int_0^1 x^2 e^{-x} dx$

26. The Trapezoidal rule applied to $\int_0^2 f(x)dx$ gives the value 5, and the Midpoint rule gives the value 4. What value does Simpson's rule give?

27. The quadrature formula $\int_0^2 f(x)dx = c_0 f(0) + c_1 f(1) + c_2 f(2)$ is exact for all polynomials of degree less than or equal to 2. Determine c_0, c_1, and c_2.

28. Romberg integration is used to approximate

$$\int_2^3 f(x)dx.$$

If $f(2) = 0.51342$, $f(3) = 0.36788$, $R_{31} = 0.43687$, and $R_{33} = 0.43662$, find $f(2.5)$.

29. Use Romberg integration to compute $R_{3,3}$ for the following integrals.

a. $\int_1^{1.5} x^2 \ln x dx$

b. $\int_0^1 x^2 e^{-x} dx$

30. Use Romberg integration to compute $R_{3,3}$ for the following integrals.

a. $\int_{-1}^1 (\cos x)^2 dx$

b. $\int_{-0.75}^{0.75} x \ln(x+1) dx$

2.19.1 Practicals Question Bank

Complex Analysis

Unit-I

1. Sketch the following sets and determine which are domains:

   (a) $|z-2+i| \leq 1$; (b) $|2z+3| > 4$;

   (c) $Imz > 1$; (d) Im z = 1;

2. Sketch the region onto which the sector $r \leq 1, 0 \leq \theta \leq \frac{\pi}{4}$ is mapped by the transformation
   (a) $w = z^2$;
   (b) $w = z^3$;
   (c) $w = z^4$.

3. Find all roots of the equation

   (a) $\sinh z = i$; (b) $\cosh z = \frac{1}{2}$;

4. Find all values of z such that

   (a) $e^z = -2$ (b) $e^z = 1 + \sqrt{3}i$ (c) $\exp(2z - 1) = 1$.

5. Show that

$$\lim_{z \to z_0} f(z)g(z) = 0$$

   if

$$\lim_{z \to z_0} f(z) = 0$$

   and if there exists a positive number M such that $|g(z)| \leq M$ for all z in some neighborhood of z_0.

6. show that $f\prime(z)$ does not exist at any point if

   (a) $f(z) = \bar{z}$ (b) $f(z) = z - \bar{z}$

   (c) $f(z) = 2x + ixy^2$ (d) $f(z) = e^x e^{-iy}$.

7. verify that each of these functions is entire:

   (a) $f(z) = 3x + y + i(3y - x)$ (b) $f(z) = \sin x \cosh y + i \cos x \sinh y$

   (c) $f(z) = e^{-y} \sin x - ie^{-y} \cos x$ (d) $f(z) = (z^2 - 2)e^{-x}e^{-iy}$.

8. State why a composition of two entire functions is entire. Also, state why any *linear combination* $c_1 f_1(z) + c_2 f_2(z)$ of two entire functions, where c_1 and c_2 are complex constants, is entire.

9. Show that $u(x, y)$ is harmonic in some domain and find a harmonic conjugate $v(x, y)$ when

(a) $u(x,y) = 2x(1-y)$

(b) $u(x,y) = 2x - x^3 + 3xy^2$

(c) $u(x,y) = \sinh x \sin y$

(d) $u(x,y) = y/(x^2+y^2)$.

10. Show that if v and V are harmonic conjugates of $u(x,y)$ in a domain D, then $v(x,y)$ and $V(x,y)$ can differ at most by an additive constant.

Unit-II

11. Evaluate

$$\int_C f(z)dz.$$

$f(z) = (z+2)/z$ and C is

(a) the semicircle $z = 2e^{i\theta}$ $(0 \le \theta \le \pi)$

(b) the semicircle $z = 2e^{i\theta}$ $(\pi \le \theta \le 2\pi)$

(c) the circle $z = 2e^{i\theta}$ $(0 \le \theta \le 2\pi)$.

12. $f(z)$ is defined by means of the equations

$$f(z) = \begin{cases} 1 & when \;\; y < 0 \\ 4y & when \;\; y > 0 \end{cases}$$

and C is the arc from $z = -1-i$ to $z = 1+i$ along the curve $y = x^3$.

13. Let C denote the line segment from $z = i$ to $z = 1$. By observing that of all the points on that line segment, the midpoint is the closest to the origin, show that

$$\left| \int_C \frac{dz}{z^4} \right| \le 4\sqrt{2}$$

without evaluating the integral.

14. Let C_R denote the upper half of the circle $|z| = R (R > 2)$, taken in the counterclockwise direction. Show that

$$\left| \int_{C_R} \frac{2z^2-1}{z^4+5z^2+4} dz \right| \le \frac{\pi R(2R^2+1)}{(R^2-1)(R^2-4)}.$$

Then, by dividing the numerator and denominator on the right here by R^4, show that the value of the integral tends to zero as R tends to infinity.

15. By finding an antiderivative, evaluate each of these integrals, where the path is any contour between the indicated limits of integration:

(a) $\int_i^{i/2} e^{\pi z} dz$

(b) $\int_0^{\pi+2i} \cos\left(\frac{z}{2}\right) dz$

(c) $\int_1^3 (z-2)^3 dz$

16. Use an antiderivative to show that for every contour C extending from a point z_1 to a point z_2,

$$\int_C z^n dz = \frac{1}{n+1}(z_2^{n+1} - z_1^{n+1}) \qquad (n = 0, 1, 2, \ldots.).$$

17. Let C_0 and C denote the circles $z = z_0 + Re^{i\theta}(-\pi \leq \theta \leq \pi)$ and $z = Re^{i\theta}(-\pi \leq \theta \leq \pi)$, respectively.
(a) Use these parametric representations to show that

$$\int_{C_0} f(z - z_0)dz = \int_C f(z)dz$$

18. Evaluate the integral

$$\int_c z^m \bar{z}^n dz,$$

where m and n are integers and C is the unit circle $|z| = 1$, taken counterclockwise.

19. $f(z) = 1$ and C is an arbitrary contour from any fixed point z_1 to any fixed point z_2 in the z plane. Evaluate

$$\int_C f(z)dz$$

20. $f(z) = \pi \exp(\pi \bar{z})$ and C is the boundary of the square with vertices at the points $0, 1, 1+i$, and i, the orientation of C being in the counterclockwise direction. Evaluate

$$\int_C f(z)dz.$$

Unit-III

21. Let C denote the positively oriented boundary of the square whose sides lie along the lines $x = \pm 2$ and $y = \pm 2$. Evaluate each of these integrals:

(a) $\int_C \frac{e^{-z}}{z-(\pi i/2)}dz$ (b) $\int_C \frac{\cos z}{z(z^2+8)}dz$ (c) $\int_C \frac{z}{2z+1}dz$

22. Find the value of the integral of $g(z)$ around the circle $|z - i| = 2$ in the positive sense when

(a) $g(z) = \frac{1}{z^2+4}$ (b) $g(z) = \frac{1}{(z^2+4)^2}$

23. C be the circle $|z| = 3$, described in the positive sense. Show that if

$$g(z) = \int_C \frac{2s^2 - s - 2}{s - z}ds \qquad (|z| \neq 3)$$

then $g(2) = 8\pi i$. What is the value of $g(z)$ when $|z| > 3$?

24. Let C be any simple closed contour, described in the positive sense in the z plane, and write

$$g(z) = \int_C \frac{s^3 + 2s}{(s - z)^3}ds$$

Show that $g(z) = 6\pi iz$ when z is inside C and that $g(z) = 0$ when z is outside.

25. Show that if f is analytic within and on a simple closed contour C and z_0 is not on C, then

$$\int_C \frac{f'(z)}{z - z_0}dz = \int_C \frac{f(z)}{(z - z_0)^2}dz.$$

26. Let C be the unit circle $z = e^{i\theta}$ $(-\pi \leq \theta \leq \pi)$. First show that for any real constant a,

$$\int_C \frac{e^{az}}{z} dz = 2\pi i.$$

Then write this integral in terms of θ to derive the integration formula

$$\int_0^{\pi} e^{a\cos\theta} \cos(a\sin\theta) d\theta = \pi.$$

27. Suppose that $f(z)$ is entire and that the harmonic function $u(x, y) = Re[f(z)]$ has an upper bound u_0 ; that is, $u(x, y) \leq u_0$ for all points (x, y) in the xy plane. Show that $u(x, y)$ must be constant throughout the plane.

28. Let a function f be continuous on a closed bounded region R, and let it be analytic and not constant throughout the interior of R. Assuming that $f(z) \neq 0$ anywhere in R, prove that $|f(z)|$ has a *minimum value* m in R which occurs on the boundary of R and never in the interior. Do this by applying the corresponding result for *maximum values* to the function $g(z) = 1/f(z)$.

29. Let the function $f(z) = u(x, y) + iv(x, y)$ be continuous on a closed bounded region R, and suppose that it is analytic and not constant in the interior of R. Show that the component function $v(x, y)$ has *maximum* and *minimum values* in R which are reached on the boundary of R and never in the interior, where it is harmonic.

30. Let f be the function $f(z) = e^z$ and R the rectangular region $0 \leq x \leq 1$, $0 \leq y \leq \pi$. Finding points in R where the component function $u(x, y) = Re[f(z)]$ reaches its *maximum* and *minimum values*.

2.20.1 Practicals Question Bank

Vector Calculus

Unit-I

1. Evaluate the line integral
$$\int_C \mathbf{F} \times \mathbf{dr},$$
where $\mathbf{F}$ is the vector field $(y, x, 0)$ and C is the curve $y = \sin x, z = 0$, between $x = 0$ and $x = \pi$.

2. Evaluate the line integral
$$\int_C x + y^2 \mathbf{dr},$$
where C is the parabola $y = x^2$ in the plane $z = 0$ connecting the points $(0, 0, 0)$ and $(1, 1, 0)$.

3. Evaluate the line integral
$$\int_C \mathbf{F.dr}$$
where $\mathbf{F} = (5z^2, 2x, x + 2y)$ and the curve C is given by $x = t, y = t^2, z = t^2, 0 \leq t \leq 1$.

4. Find the line integral of the vector field $\mathbf{u} = (y^2, x, z)$ along the curve given by $z = y = e^x$ from $x = 0$ to $x = 1$.

5. Evaluate the surface integral of $\mathbf{u} = (y, x^2, z^2)$, over the surface S, where S is the triangular surface on $x = 0$ with $y \geq 0, z \geq 0, y + z \leq 1$, with the normal n directed in the positive x direction.

6. Find the surface integral of $\mathbf{u} = \mathbf{r}$ over the part of the paraboloid $z = 1 - x^2 - y^2$ with $z > 0$, with the normal pointing upwards.

7. If S is the entire x, y plane, evaluate the integral
$$I = \iint_S e^{-x^2-y^2} dS,$$
by transforming the integral into polar coordinates.

8. Find the line integral $\oint_C \mathbf{r} \times \mathbf{dr}$ where the curve C is the ellipse $x^2/a^2 + y^2/b^2 = 1$ taken in an anticlockwise direction. What do you notice about the magnitude of the answer?

9. By considering the line integral of $\mathbf{F} = (y, x^2 - x, 0)$ around the square in the x, y plane connecting the four points$(0, 0), (1, 0), (1, 1)$ and $(0, 1)$, show that $\mathbf{F}$ cannot be a conservative vector field.

10. Evaluate the line integral of the vector field $\mathbf{u} = (xy, z^2, x)$ along the curve given by $x = 1 + t, y = 0, z = t^2, 0 \leq t \leq 3$.

Unit-II

11. A cube $0 \leq x, y, z \leq 1$ has a variable density given by $\rho = 1 + x + y + z$. What is the total mass of the cube?

12. Find the volume of the tetrahedron with vertices $(0,0,0)$, $(a,0,0)$, $(0,b,0)$ and $(0,0,c)$.

13. Evaluate the surface integral of $\mathbf{u} = (xy, x, x+y)$ over the surface S defined by $z = 0$ with $0 \leq x \leq 1, 0 \leq y \leq 2$, with the normal $\mathbf{n}$ directed in the positive z direction.

14. Find the surface integral of $\mathbf{u} = \mathbf{r}$ over the surface of the unit cube $0 \leq x, y, z \leq 1$, with $\mathbf{n}$ pointing outward.

15. The surface S is defined to be that part of the plane $z = 0$ lying between the curve $y = x^2$ and $x = y^2$. find the surface integral of $\mathbf{u.n}$ over S where $\mathbf{u} = (z, xy, x^2)$ and $\mathbf{n} = (0,0,1)$.

16. Find the surface integral of $\mathbf{u.n}$ over S where S is the part of the surface $z = x + y^2$ with $z < 0$ and $x > -1$, u is the vector field $\mathbf{u} = (2y + x, -1, 0)$ and $\mathbf{n}$ has a negative z component.

17. Find the volume integral of the scalar field $\phi = x^2 + y^2 + z^2$ over the region V specified by $0 \leq x \leq 1$, $1 \leq y \leq 2$, $0 \leq z \leq 3$.

18. Find the volume of the section of the cylinder $x^2 + y^2 = 1$ that lies between the planes $z = x + 1$ and $z = -x - 1$.

19. Find the unit normal $\mathbf{n}$ to the surface $x^2 + y^2 - z = 0$ at the point $(1,1,2)$.

20. Find the gradient of the scalar field $f = xyz$ and evaluate it at the point $(1,2,3)$. Hence find the directional derivative of f at this point in the direction of the vector $(1,1,0)$.

Unit-III

21. Find the divergence of the vector field $\mathbf{u} = \mathbf{r}$.

22. The vector field $\mathbf{u}$ is defined by $\mathbf{u} = (xy, z + x, y)$. Calculate $\nabla \times \mathbf{u}$ and find the point where $\Delta \times \mathbf{u} = 0$.

23. Find the gradient $\nabla\phi$ and the Laplacian $\nabla^2\phi$ for the scalar field $\phi = x^2 + xy + yz^2$.

24. Find the gradient and the Laplacian of

$$\phi = \sin(kx)\sin(ly)e^{\sqrt{k^2+l^2}z}.$$

25. Find the unit nirmal to the surface $xy^2 + 2yz = 4$ at the point $(-2,2,3)$.

26. For $\phi(x,y,z) = x^2 + y^2 + z^2 + xy - 3x$, find $\nabla\phi$ and find the minimum value of ϕ.

27. Find the equation of the plane which is tangent to the surface $x^2 + y^2 - 2z^3 = 0$ at the point $(1,1,1)$.

28. Find both the divergence and the curl of the vector fields

    (a) $\mathbf{u} = (y, z, x)$;

(b) $\mathbf{v} = (xyz, z^2, x - y)$.

29. For what values, if any, of the constants a and b is the vector field $\mathbf{u} = (y\cos x + axz, b\sin x + z, x^2 + y)$ irrotational?

30. (a) Show that $\mathbf{u} = (y^2 z, -z^2 \sin y + 2xyz, 2z\cos y + y^2 x)$ is irrotational.

(b) Find the corresponding potential function.

(c) Hence find the value of the line integral of $\mathbf{u}$ along the curve $x = \sin \pi t/2, y = t^2 - t, z = t^4, 0 \leq t \leq 1$.
