G 6761 (Pages : 2) Reg. No..

Name..

B.TECH. DEGREE EXAMINATION, APRIL 2011

Third Semester

Branch : Electronics and Communication, Applied Electronics and Instrumentation Electronics and Instrumentation Engineering

SOLID STATE DEVICES (LAS)

(2002 admission onwards—Supplementary)

Time : Three Hours Maximum : 100 Marks

Part A

Answer **all** *questions briefly.*
Each carries 4 marks.

1. Write and explain Fermi-Dirac function. Define the Fermi Energy level.
2. What is meant by carrier life time ? How does it affect the performance of a device ?
3. Define diffusion and space charge capacitances in a *p-n* junction. Describe the physical causes and cocnepts of these two.
4. Define and distinguish between Drift and Diffusion currents in a semiconductor.
5. Sketch and lable the VI characteristics of a tunnel diode.
6. Draw the equivalent circuits for a zener diode in the (i) forward bias ; (ii) in the zener breakdown region.
7. Why, generally power transistors have lower values of α ?
8. Define α and β and derive the relation between them.
9. Draw and explain the CV diagram of a MOS capacitor.
10. Explain clearly the VVR operation of a JFET.

(10 × 4 = 40 marks)

Part B

Answer either Section (a) or (b) of each module.
Each full question carries 12 marks.

MODULE 1

11. (a) With, help of neat energy band diagrams, distinguish clearly the electrical properties of a metal, insulator and semiconductor.

(12 marks)

Or

Turn over

(b) (i) Describe how the hall effect can be used to determine the mobility of a carrier in a semi-conductor sample.

(7 marks)

(ii) A sample of silicon is doped with 10^{18} phosphorus atoms percubic centimeter. What is the hall voltage if the sample is 100 μm thick $I_x = 1$ mA, $B_z = 10^{-5}$ Wb/cm.^{2}, $\mu = 700$ cm.^{2}/V-sec.

(5 marks)

MODULE 2

12. (a) (i) Derive an expression for the law of the *pn*-junction. Show how does the law explain the shape of the VI characteristics.

(6 marks)

(ii) Using neat sketches, describe all the current components of a diode when (i) Forward biased ; (ii) Reverse biased.

Or

(b) What are the different types of current components in a *p-n* junction when forward biased. Derive an expression for the total current.

(12 marks)

MODULE 3

13. (a) (i) What is the tunneling phenomena in a zener diode ? Explain with the help of energy band diagram.

(8 marks)

(ii) With the help of necessary equations, explain the working principle of varactor diode ?

(4 marks)

Or

(b) Neatly sketch the VI characteristics (forward and reverse) of a rectifier diode. Explain the parameters forward and reverse dynamic and static resistances and breakdown voltage, giving typical values.

(12 marks)

MODULE 4

14. (a) Draw and explain the energy band diagram of an *npn* transistor biased in the active region. Sketch the potential distribution in the above case.

(12 marks)

Or

(b) With a neat diagram, explain how a weak voltage is amplified by a *pnp*-transistor ?

(12 marks)

MODULE 5

15. (a) Sketch the drain and transconductance characteristics of a JFET and explain with the help of FET structure, the shape of each curve.

(12 marks)

Or

(b) With a neat constructional diagram, explain the working of an *n*-channel enhancement MOSFET. Sketch its drain characteristics and explain the shape of the curves.

(12 marks)

[5 × 12 = 60 marks]

G 6768 (Pages : 2) Reg. No..................................

Name..................................

B.TECH. DEGREE EXAMINATION, APRIL 2011

Third Semester

Branch : Electronics and Communication, Applied Electronics and Instrumentation, Electronics and Instrumentation Engineering

ELECTRONIC CIRCUITS I (LAS)

(2002 admission onwards)

[Supplementary]

Time : Three Hours Maximum : 100 Marks

Part A

Answer **all** *questions briefly.*
Each carries 4 *marks.*

1. With a neat block diagram, explain the essential functional circuits in a d.c. power supply.
2. With a circuit diagram, explain the 3-pin monolithic regulated IC power supply for generating +5 Volt.
3. Compare the CE, CB, and CC configurations with respect to their input and output resistances, giving typical values.
4. Draw the small signal model of FET and list its parameters.
5. Define AC and DC load lines of a self biased circuit and sketch them on a single graph.
6. Draw a transistor amplifier circuit to compensate for I_{CO} and explain its working.
7. Which parameters decide the f_L and f_H of an RC coupled amplifier ? Explain.
8. Draw the fixed biased amplifier circuit using JFET and write the design equations.
9. Draw a positive clamper using diode and explain. What are the factors to be followed to have good clamped output ?
10. With a circuit diagram, explain the switching characteristics of BJT.

(10 × 4 = 40 marks)

Part B

Answer any **one** *full question from each Module.*
Each full question carries 12 *marks.*

Module 1

11. (a) Use a centre tapped FWR with capacitor filter. Draw the complete circuit and design it to obtain 12 Volt d.c. with 0.01% ripple.

Or

Turn over

(b) Draw the circuit of a series pass voltage regulator with feedback and short circuit protection. Design the circuit for V_o = 6 Volt; I_{max} = 120 mA.

Module 2

12. (a) Draw the circuit of a cc amplifier. Using h-parameter, deduce its equivalent circuit. Derive expressions for its R_i, R_o, A_i and A_v.

Or

(b) An amplifier has $h_{ie} = 1.1k\,\Omega$, $h_{re} = 2\times10^{-4}$, $h_{fe} = 120$, $h_{oe} = 2\times10^{-6}\,℧$, $R_s = 600\,\Omega$, $R_L = 1k\,\Omega$. Calculate :

(i) R_i, (ii) R_o, (iii) A_i, (iv) A_v, (v) A_{is}, (vi) A_{vs}.

Module 3

13. (a) BC 107 having $\beta = 150$, $h_{ie} = 1.2\,k\Omega$ is used to assemble an amplifier in potential divider bias with $R_1 = 12\,k\Omega$, $R_2 = 91\,k\Omega$, $R_E = 910\,\Omega$, $R_c = 4.7\,k\Omega$, $C_1 = C_2 = 10\mu F$, $C_E = 220\,\mu F$, $R_s = 600\,\Omega$, $R_L = 1k\,\Omega$. Draw the circuit, calculate (i) R_i, (ii) R_o, (iii) A_v, (iv) AL_i, of the circuit.

Or

(b) With a neat circuit diagrams, compare and contrast the performances and merits of (i) collector-to base feedback bias circuit and (ii) emitter bias circuit.

Module 4

14. (a) Draw the circuit of an RC coupled and BJT amplifier. Design the same for f_L = 20 Hz, A_i = 120, f_T = 2000 kHz, Make a reasonable assumptions.

Or

(b) Draw circuit of a self bias FET amplifier. Design the same for A_v = 30, making necessary assumptions.

(6 marks)

Module 5

15. (a) (i) With sine wave inputs, describe the working of (i) positive biased clamper (ii) negative biased clamper circuits.

(8 marks)

(ii) Prove that the RC high pass filter circuit acts as a differentiator. (4 marks)

Or

(b) Draw the circuit of an astable multivibrator using BJT and derive the frequency of its oscillation. Design the circuit to generate 750 Hz at 6 V amplitude.

(5 × 12 = 60 marks)

G 6775 (Pages : 2) Reg. No..................................

Name......................................

B.TECH. DEGREE EXAMINATION, APRIL 2011

Third Semester

Branch : Electronics and Communication, Applied Electronics and Instrumentation, Electronics and Instrumentation Engineering

COMPUTER PROGRAMMING (L A S)

(2002 admission onwards)

[Supplementary]

Time : Three Hours Maximum : 100 Marks

Write neat and efficient C programs wherever necessary.

Part A

Answer **all** *questions briefly.*
Each carries 4 marks.

1. Distinguish between variables, constants and keywords with suitable examples.
2. List all the relational operators and their precedence.
3. Explain the use of a switch statement with an example.
4. What is a recursion ? Write a recursion to find factorial of an integer.
5. Explain how ID and 2 D initialization is done ? Give an example.
6. Write a statement to create 3 × 3 array and assign a value 1 to the elements of the first row, 2 to the elements of the second row and 3 to the elements of the third row.
7. What is meant by function pointer ? Give an example.
8. Distinguish between call by value and call by reference.
9. List various bitwise operators and explain how they are used ?
10. Describe two different approaches to update a data file ? Which is better ? Why ?

(10 × 4 = 40 marks)

Part B

Answer any **one** *full question from each module.*
Each full question carries 12 marks.

Module 1

11. (a) (i) Differentiate between scanf and gets functions giving their syntax. (4 marks)

(ii) Write an interactive C program to find the ASCII of a given integer number. (8 marks)

Or

Turn over

(b) (i) List and explain various format field specifications of printf statements. (4 marks)

(ii) Describe with suitable examples, all the operators in C, specifying the hierarchy of operations.

(8 marks)

Module 2

12. (a) Write a C program to calculate the GCD and LCM of two given numbers.

Or

(b) Write a function to check if a number is prime or not. Call it from a main program.

Module 3

13. (a) Differentiate structures and unions with appropriate examples. Write a program to read two student structures with fields (reg.no, name, branch, sex, mark 1, mark 2, mark 3, mark 4, mark 5 and mark 6) and display them.

Or

(b) Write a C program that reads the name and address of N students, along with their heights and rearrange in the increasing order of their heights. Prepare the roll list in this order.

Module 4

14. (a) Write a.c.program using pointers to find the biggest of given list of *n* integers.

Or

(b) Write a C program to declare a structure with data members employee number, employee name and basic pay of the employee. Declare a structure pointer and an array EMPLOY with 100 elements. The program should read *'n'* employee details and print the list of all employees along with the basic pay.

Module 5

15. (a) A student master file consists of register number, name and marks in six subjects. Write a C program which will read the file and print a list of students who have failed in one *or* more subjects. Assume 50% in the pass mark.

Or

(b) (i) List and explain any *three* preprocessor directives with examples. (6 marks)

(ii) Explain command line arguments with suitable examples. (6 marks)

[5 × 12 = 60 marks]

G 6753 (Pages : 3) Reg. No................................

Name..................................

B.TECH. DEGREE EXAMINATION, APRIL 2011

Third Semester

Branch : Electronics and Communication, Applied Electronics and Instrumentation, Electronics and Instrumentation Engineering

ELECTRICAL TECHNOLOGY (L A S)

(2002 admission onwards—Supplementary)

Time : Three Hours Maximum : 100 Marks

Part A

Answer **all** *questions briefly.*
Each question carries 4 marks.

1. Discuss the various types of excitation in a d.c. generator.
2. Draw the open circuit characteristics of a DC generator and explain its shape.
3. Explain dynamic braking in a d.c. motor.
4. What is the necessity of a starter for a d.c. motor ? Why small motors can be started without a starter ?
5. What are the losses in a transformer ? On what factors these losses depend ?
6. Derive an expression for the e.m.f. in a transformer in terms of frequency, maximum value of flux and number of turns of the windings. Hence obtain the transformation ratio.
7. State the advantages of having stationary armature in an alternator.
8. What are damper winding ? Explain their purpose in synchronous motors.
9. What is the principle of stepper motor ? What are its applications ?
10. Explain the working principle of a tacho generator.

($10 \times 4 = 40$ marks)

Part B

Answer **either** *section A* **or** *B of each module.*
Each full question carries 12 marks.

Module 1

11. A (i) Explain how d.c. generators are classified. (4 marks)

(ii) A d.c. shunt generator supplies a load of 8 kW at 200 V. Calculate the induced e.m.f. if the armature resistance is 0.6 Ω and field resistance is 80 Ω.

(8 marks)

Or

Turn over

(B) (i) A 4 pole, lap wound d.c. shunt generator has a useful flux per pole of 0.07 Wb. The armature winding consists of 220 turns each of 0.004 Ω resistance. Calculate the terminal voltage when running at 900 r.p.m. if the armature current is 50 A.

(6 marks)

(ii) A 4 pole separately excited d.c. generator has a lap connected armature with 440 conductors. The armature resistance is 0.02 Ω with an output current of 400 A from the armature. The terminal voltage is 210 V when the machine is driven at 900 r.p.m. Determine the useful flux per pole.

(6 marks)

Module 2

12. A A 200 V d.c. motor takes 4A from line on no load. $R_a = 0.5\ \Omega$ and $R_{sh} = 200\ \Omega$. Determine the efficiency of the d.c. machine (i) as a generator supplying 10 A to a load and (ii) as a motor taking 10 A from line.

(12 marks)

Or

B When running on no-load, a 400 V shunt motor takes 5 A. Armature resistance is 0.5 Ω and field resistance 200 Ω. Estimate the power output and efficiency when the motor runs on full load and takes 50A from the line, neglecting contact drop. Also find the percentage change in speed from no-load to full-load.

(12 marks)

Module 3

13. A A 25 kVA, 2000/200 V transformer the iron and copper losses at full load are 300 W and 400 W respectively. Calculate the efficiency at u.p.f. at (i) full load ; (ii) half load ; (iii) determine the load at which the maximum efficiency occurs, as well as iron and copper losses at this load.

(12 marks)

Or

B A transformer has copper lsos of 1.5 % and reactance 3.5 % when tested on load. Calculate its full-load regulation at (i) unity power fctor ; (ii) 0.9 p.f. lagging ; and (iii) 0.8 p.f. leading.

(12 marks)

Module 4

14. A A 50 Hz, 8 pole induction motor has a full-load slip of 4 %. The rotor resistance is 0.001 Ω per phase and standstill reactance is 0.005 Ω per phase. Find the ratio of the maximum to the full-load torque and the speed at which the maximum torgue occurs.

(12 marks)

Or

B A 3-phase, 8 pole alternator is star-connected. The stator has 160 slots with 6 conductors per slot with full-pitched distributed winding. If the rotor speed is 750 r.p.m., estimate the flux required in the air-gap to generate an e.m.f. of 1000 V between the lines. Assume a distribution factor of 0.85.

(12 marks)

Module 5

15. A With neat diagrams describe the constructional details and working of DC servo motor.

(12 marks)

Or

B With neat constructional diagrams describe the working principle and applications of :

(i) Contactors.

(ii) Electromagnetic relays.

(6 + 6 = 12 marks)

[5 × 12 = 60 marks]

(ii) A RL series network has a step input of E volts applied across it. Use Laplace transform to develop expressions for the voltage across the inductance L. Assume that at time $t = 0$, current $i = 0$.

(6 marks)

Module 4

14. (a) (i) Express h parameters in terms of z-parameters. (4 marks)

(ii) For a certain two port network V_1 and V_2 are given by :

$$V_1 = 60\,I_1 + 20\,I_2$$
$$V_2 = 20\,I_1 + 40\,I_2.$$

Find the y parameters and draw the network.

(8 marks)

Or

(b) A low pass filter is composed of symmetrical π section. Each series arm is 0.02H and shunt arm is 2 μF capacitor. Calculate :

(i) Cut-off frequency.

(ii) Characteristic impedance at zero frequency.

(iii) Characteristic impedance at Hz and 2000 Hz.

(iv) Attenuation at 200 Hz and 2000 Hz.

(12 marks)

Module 5

15. (a) (i) The driving point impedance of an LC network is given by $Z(s) = \dfrac{10s^4+12s^2+1}{2s^3+2s}$.

(6 marks)

(ii) Is it possible to realise $Y(s) = \dfrac{(s+2)(2s+7)}{(s+1)(s+3)}$ in the second form of RC Cauer network. If yes, realise the same.

(6 marks)

Or

(b) Test the following function for positive reality :

$$H(s) = \frac{s^4+2s^3+3s^2+s+1}{s^4+s^3+3s^2+2s+1}$$

(12 marks)

[5 × 12 = 60 marks]

G 6745

(Pages : 4)

Reg. No.................................

Name...................................

B.TECH. DEGREE EXAMINATION, APRIL 2011

Third Semester

Electronics and Communication, Applied Electronics and Instrumentation, Electronics and Instrumentation Engineering

NETWORK THEORY (L A S)

(2002 admission onwards—Supplementary)

Time : Three Hours

Maximum : 100 Marks

Part A

Answer **all** *questions briefly.*
Each question carries 4 marks.

1. With the help of neat sketches, explain the difference between dependent sources and independent sources.
2. Replace the following network with a single voltage source and resistor only (Fig. 1) :

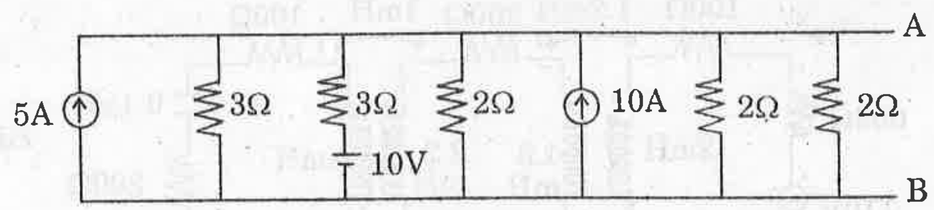

Fig. 1

3. Define the following (i) oriented graph ; (ii) co-tree ; (iii) planar graph ; and (iv) subgraph as applied to network topology.
4. What is complete incidence matrix ? Explain with an example.
5. State and prove final value theorem.
6. Find the Fourier Transform of $f_1(t) = \begin{cases} e^{at}, & t < 0 \\ e^{-at}, & t > 0 \end{cases}$.
7. Draw a constant-K high pass filter. Write the expression for its cut-off frequency.
8. Explain the condition for symmetry for a two-port network. Show the symmetry for z-parameters.
9. Write a short note on Brune's positive real function.
10. With circuit examples, describe Foster and Cauer RL networks.

(10 × 4 = 40 marks)

Turn over

Part B

*Answer **one** full question from each module.*
Each full question carries 12 marks.

Module 1

11. (a) Find the branch currents i_1, and i_2 using Laplace techniques of circuit transformation, considering all initial conditions as zero.

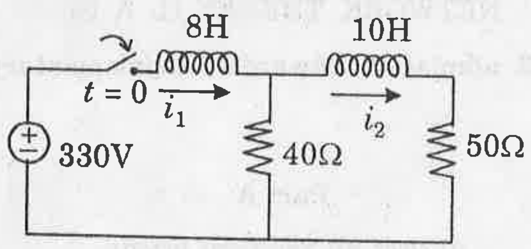

Fig. 2

Or

(b) Write the mesh equation for the circuit shown in Fig. 3. Also find the input impedance.

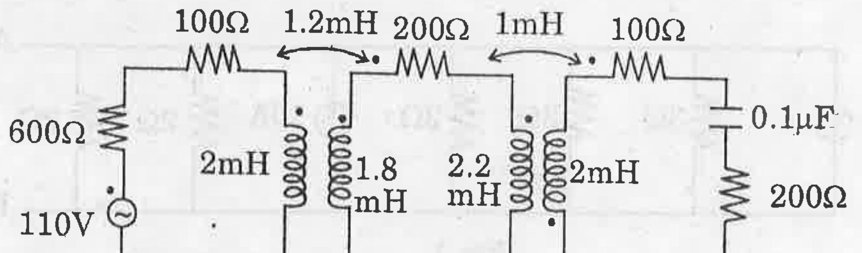

Fig. 3

Module 2

12. (a) Determine the voltage drop across the resistor R_2 of the circuit shown in Fig. 4 using superposition theorem.

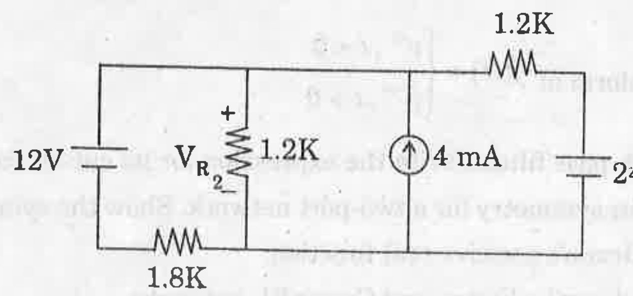

Fig. 4

Or

(b) For the oriented graph shown in Fig. 5, write the complete incidence matrix. Also write the cut-set and tie-set matrices considering branches 4, 5 and 6 twigs.

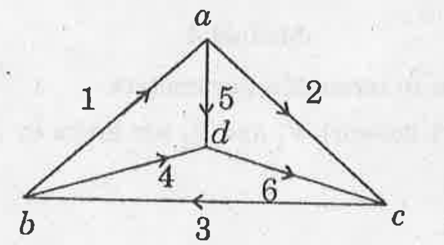

Fig. 5

Module 3

13. (a) (i) Find the Fourier series representation of the wave shown in fig. 6.

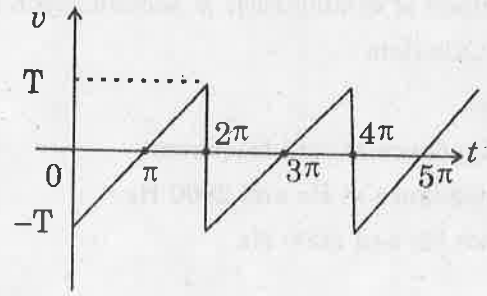

Fig. 6

(6 marks)

(ii) Obtain the inverse Laplace Transform of :

$$F(s) = \frac{(s-2)}{s(s+1)^3}.$$

(6 marks)

Or

(b) (i) Find the trigonometric Fourier series for the waveform shown in Fig. 7.

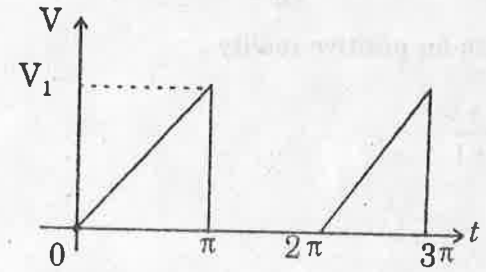

Fig. 7

(6 marks)

Turn over

G 6741 (Pages : 3) Reg. No. ECE

Name.................................

B.TECH. DEGREE EXAMINATION, APRIL 2011

Third Semester

Branch : Civil, Mechanical, Electrical and Electronics, Polymer Electronics and Communication, Applied Electronics and Instrumentation, Instrumentation and Control Electronics and Instrumentation, Automobile Engineering, Aeronautical Engineering

ENGINEERING MATHEMATICS—II (CMEPLANSUF)

(2002 admission onwards—Supplementary)

Time : Three Hours Maximum : 100 Marks

Answer any **one** *full question from each module.*
Each full question carries 20 marks.

Module 1

1. (a) Find a unit vector normal to the surface $z = x^2 + y^2$ at the point (1, 3, 4). (5 marks)

   (b) Find the directional derivative of the function $\phi = xy + yz + zx$ at (2, 1, 3) along $3\vec{i} + 4\vec{j} + 5\vec{k}$. (6 marks)

   (c) Prove that curl curl $\vec{F}$ = grad div $\vec{F} - \nabla^2\vec{F}$ and hence deduce that curl curl curl curl $\vec{F} = \nabla^4 \vec{F}$, if $\vec{F}$ is solenoidal. (9 marks)

   Or

   (d) If $\phi = \phi(r)$ show that div $\{\phi(r)\vec{r}\} = 3\phi(r) + r\phi'(r)$ Hence evaluate div $(\phi(r)\vec{r})$. (8 marks)

   (e) Find the constants a and b so that $\vec{F} = (axy + x^3)\hat{i} + (3x^2 - z)\hat{j} + (bxz^2 - y)\hat{k}$ is irrotational and find ϕ such that $\vec{F} = \nabla\phi$. (7 marks)

   (f) Define the gradient of a scalar function. Show that $\nabla\phi$ is a vector normal to the surface $\phi(x, y, z) = c$. (5 marks)

Module 2

2. (a) Find the circulation $\vec{F}$ around the closed curve C, where $\vec{F} = y\vec{i} + z\vec{j} + x\vec{k}$ and C : curve $x^2 + y^2 = 1, z = 0$. (5 marks)

   (b) State Gauss theorem and use it to evaluate $\iint_S \vec{F}\cdot\hat{n}ds$ where $\vec{F} = x^2\hat{i} + y\hat{j} + z\hat{k}$ and S is the surface of the cube bounded by the planes $x = 0, x = a, y = 0, y = a$ and $z = 0, z = a$. (8 marks)

   (c) Find the work done in moving a particle once round a circle (in the xy plane) which has centre at the origin and radius = 2. Given that the force field is $\vec{F} = (2x - y + 2z)\hat{i} + (x + y - z^2)\hat{j} + (3x - 2y - 5z)\hat{k}$. (7 marks)

Turn over

(d) Using Green's theorem, evaluate $\int (x^2 + xy)\,dx + (x^2 - y^2)\,dy$ where C is the square formed by the lines $x = \pm 1, y = \pm 1$.

(10 marks)

(e) Verify divergence theorem for $\vec{F} = (x^2 - y^2)\hat{i} + (y^2 - 2x)\hat{j} + (z^2 - xy)\hat{k}$ taken over the rectangular parallelopiped $0 \le x \le a, 0 \le y \le b, 0 \le z \le c$.

(10 marks)

Module 3

3. (a) Construct the analytic function whose real part is $r^2 \cos 2\theta$. (5 marks)

(b) (i) Does the function $f(z) = \begin{cases} e^{-(1/z^4)}, & z \ne 0 \\ 0, & z = 0 \end{cases}$ satisfy the Cauchy-Riemann equations at $z = 0$?

(5 marks)

(ii) For what values of z is $f(z)$ analytic ? (5 marks)

(iii) Show that f is continuous at $z = 0$. (5 marks)

Or

(c) If $\phi + i\psi$ represents the complex potential of an electrostatic field where $\psi = (x^2 - y^2) + \dfrac{x}{x^2 + y^2}$, find the complex potential as a function of the complex variable z and hence determine ϕ.

(8 marks)

(d) Find the bilinear transformation which maps the points $z = 1, i, -1$ into $w = 0, 1, \infty$.

(7 marks)

(e) If $f(z) = u + iv$ is analytic, show that $u = c$, and $v = c_2$ cut orthogonally.

(5 marks)

Module 4

4. (a) Prove that $e^x = \left[\dfrac{\Delta^2}{E}\right] e^x \cdot \dfrac{Ee^x}{\Delta^2 e^x}$, the interval of differencing being h. (5 marks)

(b) Prove the identify :

$$u_1 x + u_2 x^2 + u_3 x^3 + \ldots = \frac{x}{1-x} u_1 + \frac{x^2}{(1-x)^2} \Delta u_1 + \frac{x^2}{(1-x)^3} \Delta^2 u_1 .$$

(7 marks)

(c) Employ Stirling's formula to compute $u_{12.2}$ from the table : ($u_x = 1 + \log \sin x$) :

x^o	:	10	11	12	13	14
$10^5 u_x$	:	23967	28060	31755	35201	38638

(8 marks)

Or

(d) Given the values :

x :	5	7	11	13	17
$f(x)$:	150	392	1452	2388	5201

Evaluate $f(9)$, using Lagrange's and Newton's divided difference formula.

(10 marks)

(e) Given

θ :	0^0	5^0	10^0	15^0	20^0	25^0	30^0
$\tan\theta$:	0	0.0875	0.1763	0.2679	0.364	0.4663	0.5774

Using Stirling's formula, show that $\tan 16^\circ = 0.2867$.

(10 marks)

Module 5

5. (a) Evaluate $\int_0^1 \dfrac{dx}{1+x}$ with $h = 0.25$ and $h = 0.5$ using trapezoidal and Simpson's 1/3rd rule and compare the values.

(10 marks)

(b) A rocket is launched from the ground. Its acceleration is registered during the first 80 seconds and is given in the table below. Using Simpson's 1/3 rd rule, find the velocity of the rocket at $t = 80$ seconds.

t(sec) :	0	10	20	30	40	50	60	70	80
$f(\text{cm/sec}^2)$:	30	31.63	33.34	35.47	37.75	40.33	43.25	46.69	50.67

(10 marks)

Or

(c) A river is 80 ft wide. The depth d in feet at a distance x ft. From one bank is given by the following table :

x :	0	10	20	30	40	50	60	70	80
d :	0	4	7	9	12	15	14	8	3

Find approximately the area of the cross-section.

(10 marks)

(d) Evaluate $\int_0^4 e^x dx$ Simpson's rule, given that $e = 2.72$, $e^2 = 7.39$, $e^3 = 20.09$, $e^4 = 54.6$ and compare it with the actual value.

(10 marks)

($5 \times 20 = 100$ marks)