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10MAT41

Fourth Semester B.E. Degree Examination, June/July 2014

Engineering Mathematics – IV

Time: 3 hrs. Max. Marks:100

Note: ***Answer FIVE full questions, selecting at least TWO questions from each part.***

PART – A

1 a. Obtain a solution upto the third approximation of y for x = 0.2 by Picard's method, given that $\frac{dy}{dx} + y = e^x$; y(0) = 1. **(06 Marks)**

b. Apply Runge-Kutta method of order 4, to find an approximate value of y for x = 0.2 in steps of 0.1, if $\frac{dy}{dx} = x + y^2$ given that y = 1 when x = 0. **(07 Marks)**

c. Using Adams-Bashforth formulae, determine y(0.4) given the differential equation $\frac{dy}{dx} = \frac{1}{2}xy$ and the data, y(0) = 1, y(0.1) = 1.0025, y(0.2) = 1.0101, y(0.3) = 1.0228. Apply the corrector formula twice. **(07 Marks)**

2 a. Apply Picard's method to find the second approximation to the values of 'y' and 'z' given that $\frac{dy}{dx} = z$, $\frac{dz}{dx} = x^3(y + z)$, given y = 1, $z = \frac{1}{2}$ when x = 0. **(06 Marks)**

b. Using Runge-Kutta method, solve $\frac{d^2y}{dx^2} - x\left(\frac{dy}{dx}\right)^2 + y^2 = 0$ for x = 0.2 correct to four decimal places. Initial conditions are x = 0, y = 1, y′ = 0. **(07 Marks)**

c. Obtain the solution of the equation $\frac{2d^2y}{dx^2} = 4x + \frac{dy}{dx}$ at the point x = 1.4 by applying Milne's method given that y(1) = 2, y(1.1) = 2.2156, y(1.2) = 2.4649. y(1.3) = 2.7514, y′(1) = 2, y′(1.1) = 2.3178, y′(1.2) = 2.6725 and y′(1.3) = 3.0657. **(07 Marks)**

3 a. Define an analytic function in a region R and show that f(z) is constant, if f(z) is an analytic function with constant modulus. **(06 Marks)**

b. Prove that $u = x^2 - y^2$ and $v = \frac{y}{x^2 + y^2}$ are harmonic functions of (x, y) but are not harmonic conjugate. **(07 Marks)**

c. Determine the analytic function f(z) = u + iv, if $u - v = \frac{\cos x + \sin x - e^{-y}}{2(\cos x - \cosh y)}$ and f(π/2) = 0. **(07 Marks)**

4 a. Find the images of the circles |z| = 1 and |z| = 2 under the conformal transformation $w = z + \frac{1}{z}$ and sketch the region. **(06 Marks)**

b. Find the bilinear transformation that transforms the points 0, i, ∞ onto the points 1, –i, –1 respectively. **(07 Marks)**

c. State and prove Cauchy's integral formula and hence generalized Cauchy's integral formula. **(07 Marks)**

PART – B

5 a. Obtain the solution of the equation $x^2\frac{d^2y}{dx^2}+x\frac{dy}{dx}+\left(x^2-\frac{1}{4}\right)y=0$. **(06 Marks)**

b. Obtain the series solution of Legendre's differential equation,

$$(1-x^2)\frac{d^2y}{dx^2}-2x\frac{dy}{dx}+n(n+1)y=0$$ **(07 Marks)**

c. State Rodrigue's formula for Legendre polynomials and obtain the expression for $P_4(x)$ from it. Verify the property of Legendre polynomials in respect of $P_4(x)$ and also find $\int_{-1}^{1} x^3P_4(x)dx$. **(07 Marks)**

6 a. Two fair dice are rolled. If the sum of the numbers obtained is 4, find the probability that the numbers obtained on both the dice are even. **(06 Marks)**

b. Given that $P(\overline{A}\cap\overline{B})=\frac{7}{12}$, $P(A\cap\overline{B})=\frac{1}{6}=P(\overline{A}\cap B)$. Prove that A and B are neither independent nor mutually disjoint. Also compute P(A/B) + P(B/A) and $P(\overline{A}/\overline{B})+P(\overline{B}/\overline{A})$. **(07 Marks)**

c. Three machines M_1, M_2 and M_3 produces identical items. Of their respective outputs 5%, 4% and 3% of items are faulty. On a certain day, M_1 has produced 25% of the total output, M_2 has produced 30% and M_3 the remainder. An item selected at random is found to be faulty. What are the chances that it was produced by the machine with the highest output? **(07 Marks)**

7 a. In a quiz contest of answering 'Yes' or 'No', what is the probability of guessing atleast 6 answers correctly out of 10 questions asked? Also find the probability of the same if there are 4 options for a correct answer. **(07 Marks)**

b. Define exponential distribution and obtain the mean and standard deviation of the exponential distribution. **(07 Marks)**

c. If X is a normal variate with mean 30 and standard deviation 5, find the probabilities that (i) $26 \le X \le 40$, (ii) $X \ge 45$, (iii) $|X-30|>5$. [Give that $\phi(0.8)=0.2881$, $\phi(2.0)=0.4772$, $\phi(3.0)=0.4987$, $\phi(1.0)=0.3413$] **(06 Marks)**

8 a. Certain tubes manufactured by a company have mean life time of 800 hrs and standard deviation of 60 hrs. Find the probability that a random sample of 16 tubes taken from the group will have a mean life time (i) between 790 hrs and 810 hrs, (ii) less than 785 hrs, (iii) more than 820 hrs. [$\phi(0.67)=0.2486$, $\phi(1)=0.3413$, $\phi(1.33)=0.4082$]. **(06 Marks)**

b. A set of five similar coins is tossed 320 times and the result is:

No. of heads:	0	1	2	3	4	5
Frequency:	6	27	72	112	71	32

Test the hypothesis that the data follow a binomial distribution. [Given that $\chi^2_{0.05}(5)=11.07$] **(07 Marks)**

c. It is required to test whether the proportion of smokers among students is less than that among the lectures. Among 60 randomly picked students, 2 were smokers. Among 17 randomly picked lecturers, 5 were smokers. What would be your conclusion? **(07 Marks)**

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10ES42

Fourth Semester B.E. Degree Examination, June/July 2014
Microcontrollers

Time: 3 hrs. Max. Marks:100

Note: ***Answer FIVE full questions, selecting at least TWO questions from each part.***

PART – A

1 a. What is microcontroller? List out the difference between CISC and RISC. **(06 Marks)**

b. Explain the 8051 block diagram and its features. **(10 Marks)**

c. Briefly explain about stack and stack pointer operation. **(04 Marks)**

2 a. Define addressing mode. Mention the various types of addressing modes with an example with respect to 8051. **(06 Marks)**

b. Explain the following instructions with an example:
(i) DIV AB (ii) SWAP A (iii) RRC A (iv) XCHD A @R_p **(08 Marks)**

c. Write an ALP to perform 16-bit × 8-bit multiplication. **(06 Marks)**

3 a. List out and explain different assembler directives used in an ALP. **(06 Marks)**

b. Briefly explain about what are the steps involve to create a program in an ALP. **(08 Marks)**

c. Calculate the time delay for the following subroutine program. Assume XTAL = 11.0592 MHz.

```
        MOV  TMOD, #01
HERE:   MOV  TLO,  #0F2H
        MOV  THO, #OFFH
        CPL P1.5
        ACALL  DELAY
        SJMP  HERE
; _____ delay using timer 0
DELAY:  SETB  TRO
AGAIN:  JNB  TFO,  AGAIN
        CLR  TRO
        CLR TFO
        RET
```

(06 Marks)

4 a. Explain about stepper motor interface with diagram and also write a 'C' program if a motor takes 90 steps to make one complete revolution and show the calculation. (Both clockwise & anticlockwise). **(12 Marks)**

b. Explain DAC interface with diagram and also write a 'C' program to generate stair case waveform. **(08 Marks)**

PART – B

5 a. Define interrupt and mention the difference between interrupts and polling method. **(06 Marks)**

b. Explain about timer/counter control logic diagram and also briefly explain various timers mode operation. **(08 Marks)**

c. List out the various types of interrupts and also write the bit pattern of IE SFR with explanation with respect to 8051. **(06 Marks)**

6 a. Briefly explain about DB-9 connector pins function. **(06 Marks)**

b. Write a 'C' program to send the messages "Normal speed" and "High speed" to the serial port. Assuming that SW is connected to pin P2.0, monitor its status and set the baud rate as follows:

SW = 0, 28,800 baud rate

SW = 1, 56K baud rate, Assume XTAL = 11.0592 MHz. **(08 Marks)**

c. Write the steps to receive and transfer data serially. **(06 Marks)**

7 a. List out the features of MSP430. **(06 Marks)**

b. Briefly explain about MSP430 architecture with diagram. **(08 Marks)**

c. Briefly explain about memory space distribution with respect to MSP430. **(06 Marks)**

8 Write short notes on :

a. Internal RAM structure of 8051

b. Special function registers

c. Bit addressable instructions

d. Built in timers. **(20 Marks)**

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10ES43

Fourth Semester B.E. Degree Examination, June/July 2014
Control Systems

Time: 3 hrs. Max. Marks:100

Note: ***Answer any FIVE full questions, selecting atleast TWO questions from each part.***

PART – A

1 a. Explain with examples open loop and closed loop control systems. List merits and demerits of both. **(10 Marks)**

b. Draw the electrical network based on torque-current analogy give all the performance equation for the Fig.Q.1(b). **(10 Marks)**

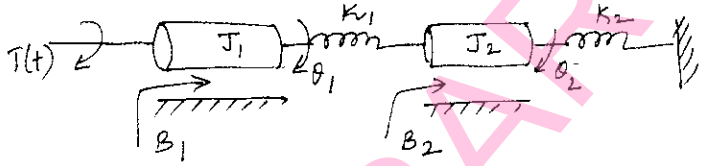

Fig.Q.1(b)

2 a. Obtain the T.F of the system using block diagram reduction method. **(10 Marks)**

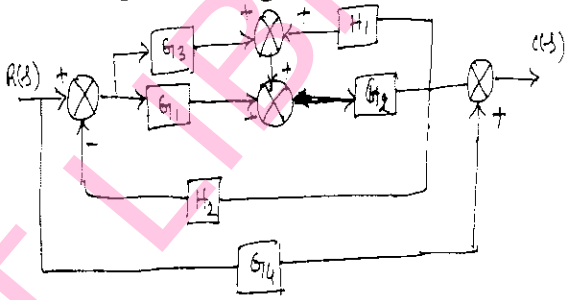

Fig.Q.2(a)

b. Obtain the transfer function using signal flow graph. By Mason's gain formula. **(10 Marks)**

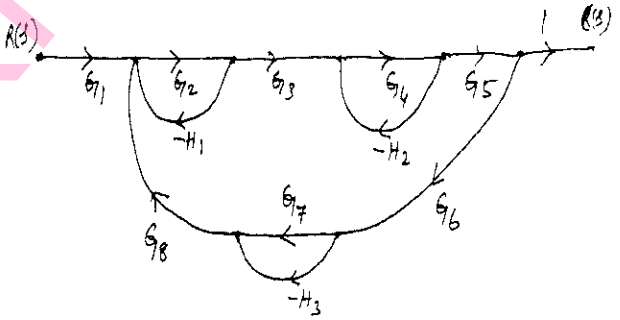

Fig.Q.2(b)

3 a. Draw the transient response characteristics of a control system to a unit step input and define the following: i) Delay time; ii) Rise time; iii) Peak time; iv) Maximum overshoot; v) Settling time. **(06 Marks)**

b. Derive the expressions for peak time t_p for a second order system for step input. **(04 Marks)**

c. The response of a servo mechanism is $c(t) = 1 + 0.2e^{-60t} - 1.2e^{-10t}$ when subjected to a unit step input. Obtain an expression for closed loop transfer function. Determine the undamped natural frequency and damping ratio. **(04 Marks)**

d. The open loop transfer function of a unity feedback system is given by $G(s) = \frac{K}{S}(ST + 1)$, where K and T are positive constant. By what factor should the amplifier, gain 'K' be reduced so that the peak, overshoot of unit step response of the system is reduced from 75% to 25%. **(06 Marks)**

4 a. Explain Routh-Hurwitz criterion in stability of a control system. **(04 Marks)**

b. The characteristics equation for certain feedback control systems are given below. Determine the system is stable or not and find the value of for a stable system
$S^3 - 3ks^2 + (k + 2)s + 4 = 0$. **(06 Marks)**

c. The open loop T.F. of a unity feedback system is given by
$$G(s) = \frac{k(s+3)}{s(s^2 + 2s + 3)(s+5)(s+6)}$$
Find the value of 'K' of which the closed loop system is stable. **(06 Marks)**

d. What are the disadvantages of RH criterion on stability of control system? **(04 Marks)**

PART – B

5 a. For a unity feedback system, the open-loop transfer function is given by $G(s) = \frac{K}{s(s+2)(s^2 + 6s + 25)}$.

i) Sketch the root locus for $0 \le K \le \infty$.
ii) At what value of 'K' the system becomes unstable.
iii) At this point of instability, determine the frequency of oscillation of the system. **(15 Marks)**

b. Consider the system with $G(s)H(s) = \frac{K}{s(s+2)(s+4)}$ find whether s = -0.75 and s = -1 + j4 is on the root locus or not using angle condition. **(05 Marks)**

6 a. Construct the Bode plots for a unity feedback control system having
$$G(s) = \frac{2000}{s(s+1)(s+100)}$$
from the Bode plots determine:
i) Gain cross over frequency.
ii) Phase cross over frequency.
iii) Gain margin.
iv) Phase margin.
Comment on stability. **(14 Marks)**

b. List the limitations of lead and lag compensations. **(06 Marks)**

7 a. The transfer function of a control system is given by $\frac{y(s)}{u(s)} = \frac{s^2 + 3s + 4}{s^3 + 2s^2 + 3s + 2}$ obtain a state model. **(10 Marks)**

b. State the properties of state transition matrix and derive them. **(10 Marks)**

8 a. Explain the procedure for investigating the stability using Nyquist criterion. **(08 Marks)**

b. Using Nyquist stability criterion, investigate the closed loop stability of a negative feedback control system whose open loop transfer function is given by
$$G(s)H(s) = \frac{K(ST_a + 1)}{S^3}, \quad K, T_a > 0.$$ **(12 Marks)**

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10EC44

Fourth Semester B.E. Degree Examination, June/July 2014
Signals and Systems

Time: 3 hrs. Max. Marks:100

Note: ***Answer any FIVE full questions, selecting atleast TWO questions from each part.***

PART – A

1 a. Determine the even and odd part of the signal x(t) shown in Fig.Q.1(a). **(06 Marks)**

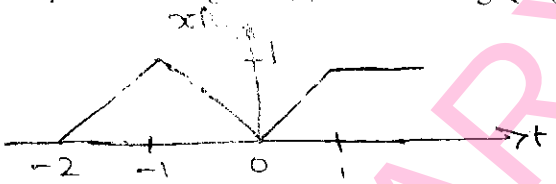

Fig.Q.1(a)

b. The signal $x_1(t)$ and $x_2(t)$ are shown in Fig.Q.1(b). Sketch the following signals:

i) $x_1(t) + x_2(t)$
ii) $x_1(t) \cdot x_2(t)$
iii) $x_1(t/2)$
iv) $x_2(2t)$
v) $x_2(t) - x_1(t)$ **(08 Marks)**

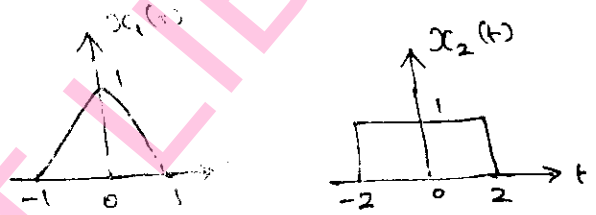

Fig.Q.1(b)

c. Check whether each of the following signals is periodic or not. If periodic determine its fundamental period:

i) $x(n) = \cos(2n)$
ii) $x(n) = (-1)^n$
iii) $x(n) = \cos\left(\frac{\pi}{8}n^2\right)$ **(06 Marks)**

2 a. Perform the convolution of the following signals shown in Fig.Q.2(a) and also sketch the o/p signal y(t). **(08 Marks)**

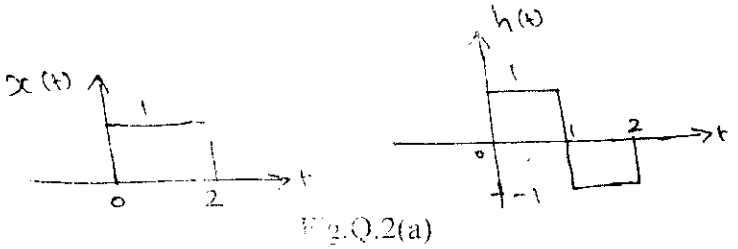

Fig.Q.2(a)

b. Compute the convolution sum of
$x(n) = \alpha^n [u(n) - u(n-8)]$, $|\alpha| < 1$ and $h(n) = u(n) - u(n-5)$. **(08 Marks)**

c. Compute the convolution of two sequences $x_1(n) = \{\underset{\uparrow}{1}, 2, 3\}$ and $x_2(n) = \{\underset{\uparrow}{1}, 2, 3, 4\}$. **(04 Marks)**

3 a. Check the followings are stable, causal, memoryless:

i) $h(t) = e^{-t}\, u(t+1)(t)$

ii) $h(t) = e^{-4|t|}$

iii) $h(n) = 2u(n) - 2\, u(n-2)$

iv) $h(n) = \delta(n) + \sin(n\pi)$. **(08 Marks)**

b. Find the total response of the system given by

$$\frac{d^2y(t)}{dt^2} + 3\frac{dy(t)}{dt} + 2y(t) = 2x(t)$$ with $y(0) = -1$, $\left.\frac{dy(t)}{dt}\right/_{t=0} = 1$ and input $x(t) = \cos t\, u(t)$. **(07 Marks)**

c. Find the difference equation corresponding to the block diagram shown in Fig.Q.3(c). **(05 Marks)**

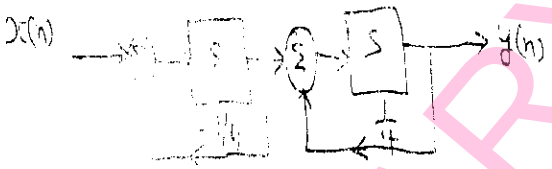

Fig.Q.3(c)

4 a. If $x(n) \xleftrightarrow{DTFS} X(k)$ and $y(n)$ [illegible] $Y(k)$, then prove that $x(n).y(n) \xleftrightarrow{DTFS} X(k) \circledcirc Y(k)$. **(07 Marks)**

b. Obtain the DTFS coefficients of $x(n) = \cos\left(\frac{6\pi}{13}n + \frac{\pi}{6}\right)$. Draw the magnitude and phase spectrum. **(06 Marks)**

c. Determine the time domain signal corresponding to the following spectra shown in Fig.Q.4(c). **(07 Marks)**

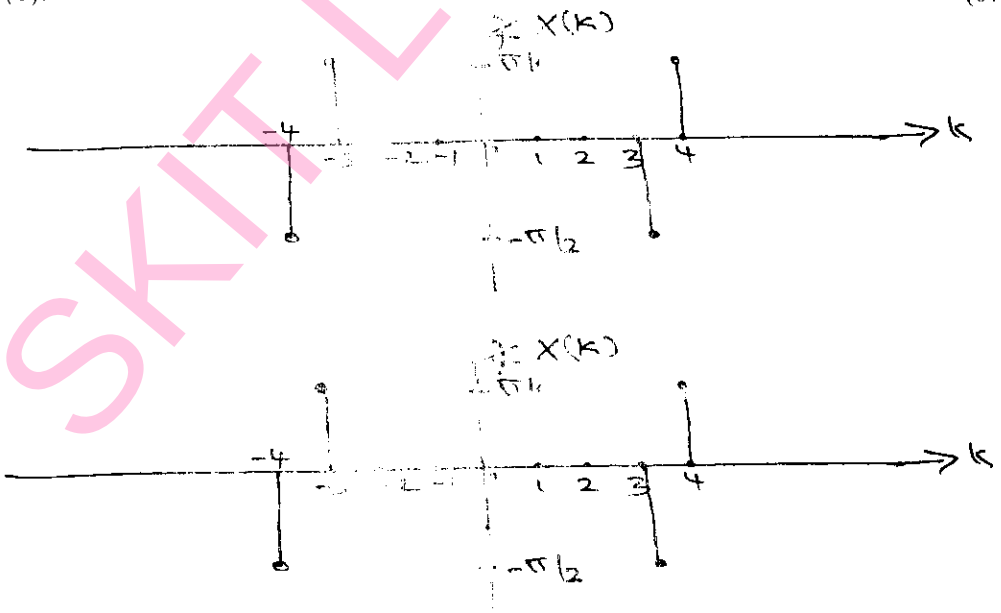

Fig.Q.4(c)

PART – B

5 a. Let $F\{x_1(t)\} = x_1(j\Omega)$ and $F\{x_2(t)\} = x_2(j\Omega)$ then prove that

$$F\{x_1(t).x_2(t)\} = \frac{1}{2\pi}\int_{\lambda=-\infty}^{\infty} x_1(j\lambda)x_2(j[illegible])\,d\lambda$$ **(07 Marks)**

b. Find the Fourier transform of the signal x(t) shown in Fig.Q.5(b). **(06 Marks)**

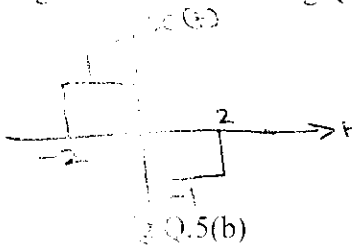

Fig.Q.5(b)

c. Find the inverse Fourier transform of

$X(jw) = \frac{jw}{(2 + jw)^2}$ using properties. **(07 Marks)**

6 a. Draw the frequency response of the system described by the impulse response $h(t) = \delta(t) - 2e^{-2t} u(t)$. **(07 Marks)**

b. Find the Fourier transform of the periodic impulse train

$\delta_{To}(t) = \sum_{k=-\infty}^{\infty} \delta(t - kTo)$ and draw the spectrum. **(08 Marks)**

c. A signal $x(t) = \cos(10\pi t) + 3\cos(30\pi t)$ is ideally sampled with sampling period Ts. Find the Nyquist rate. **(05 Marks)**

7 a. Determine Z-transform of the following functions and also find the ROC:

i) $x(n) = (0.8)^n u(-n-1)$

ii) $x(n) = -u(-n-1) + \left(\frac{1}{2}\right)^n u(n)$ **(08 Marks)**

b. If $x(n) \xleftrightarrow{Z} X(z)$, with ROC = R then prove that $n.x(n) \xleftrightarrow{Z} -z\frac{X(z)}{dz}$ with ROC = R. **(06 Marks)**

c. Determine the inverse Z-transform of the function

$X(z) = \frac{3z^2 + 2z + 1}{z^2 + 3z + 2}$. **(06 Marks)**

8 a. Determine the impulse response of the sequence described by

$y(n) - 2y(n-1) - y(n-2) = x(n) + 3x(n-1)$ **(08 Marks)**

b. Solve the following difference equation using unilateral Z-transform:

$y(n) - \frac{3}{2}y(n-1) + \frac{1}{2}y(n-2) = x(n)$, for $n \geq 0$ with initial conditions y(-1) = 4, y(-2) = 10 and i/p $x(n) = \left(\frac{1}{4}\right)^n u(n)$. **(08 Marks)**

c. Define stability and causality with respect to Z-transform. **(04 Marks)**

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10EC45

Fourth Semester B.E. Degree Examination, June/July 2014

Fundamentals of HDL

Time: 3 hrs. Max. Marks:100

Note: ***Answer FIVE full questions, selecting at least TWO questions from each part.***

PART – A

1 a. Mention the types of HDL descriptions. Explain how half adder can be modeled in VHDL and verilog in any one description method. **(10 Marks)**

b. Discuss the shift operators used in VHDL and verilog with example. **(04 Marks)**

c. Write switch level description of an inverter in verilog. **(03 Marks)**

d. A = 110, B = 111, C = 011000, D = 111011, evaluate A and not B or C nor 2 and D. **(03 Marks)**

2 a. Write a data flow description in VHDL for two-bit magnitude comparator. Show simulation waveforms. **(08 Marks)**

b. Write a verilog code to realize D-latch with active high enable in data flow modeling method. Show simulation waveforms. **(06 Marks)**

c. Write HDL code for 2 × 2 combinational array multiplier (VHDL or verilog). **(06 Marks)**

3 a. Write a VHDL code to realize JK flipflop with synchronous reset. **(04 Marks)**

b. Write verilog description to realize:
i) 3-bit counter using case statement
ii) 4:1 multiplexer using if statement **(06 Marks)**

c. Explain Booth algorithm with an example and write the flow chart of Booth multiplication algorithm. Write VHDL or verilog code of 4 × 4 bit Booth algorithm. **(10 Marks)**

4 a. Write the VHDL description of a 2:4 decoder using structural modeling method. **(05 Marks)**

b. Write the excitation table of an SRAM memory cell and write its structural description in VHDL or verilog. **(10 Marks)**

c. Write the structural description of a 4-bit asynchronous down counter using generate statement in verilog. **(05 Marks)**

PART – B

5 a. Write a VHDL/verilog code to convert unsigned binary to an integer using procedure/task. **(06 Marks)**

b. Write a VHDL/verilog description to find the floating sum $y = \sum_{i=0}^{3} (-1)^i (x)^i$; $0 < x < 1$ using function. **(06 Marks)**

c. Write a VHDL code to write integers to a file. **(08 Marks)**

6 a. Discuss about mixed type description and its advantages. Illustrate with an example. **(06 Marks)**

b. Write short notes on VHDL package and discuss the syntax of declaration of a package. **(07 Marks)**

c. Write the VHDL/verilog description of 16 × 8 SRAM. **(07 Marks)**

7 a. Explain how a VHDL entity can be invoked from a verilog module with full adder as an example. **(10 Marks)**

b. Write the mixed language description to invoke verilog module of JK flip-flop with clear from VHDL module. **(10 Marks)**

8 a. Discuss mapping of signal assignment statement and variable assignment statement to gate-level with suitable examples. **(05 Marks)**

b. Explain mapping of if-else statement with a suitable example. **(05 Marks)**

c. Show the synthesis information extracted from the listing shown below:

```
Package codes is
type op is (add, mul, divide, none);
end;
work codes;
entity ALUS2 is
Port (a, b: in std_logic_vector (3 downto 0);
      cin: in std_logic;
      opc: in op;
      z: out std_logic_vector (7 downto 0);
      cout: out std_logic;
      crr: out Boolean);
end ALUS2;
```

(10 Marks)

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10EC46

Fourth Semester B.E. Degree Examination, June/July 2014
Linear ICs and Applications

Time: 3 hrs. Max. Marks:100

Note: ***Answer FIVE full questions, selecting at least TWO questions from each part.***

PART – A

1 a. Define the following parameters and mention its practical values for op-Amp 741.
(i) CMRR (ii) Slew-rate (iii) PSRR (iv) Output offset voltage. **(08 Marks)**

b. Explain direct-coupled two I/P-Inverting summing amplifier with neat diagram and necessary design steps. **(06 Marks)**

c. A non-inverting amplifier is to amplify a 100 m.V signal to a level to 5 V. Using a 741 op-Amp, design a suitable circuit. **(06 Marks)**

2 a. Sketch the circuit of a high Z_{in} - capacitor –coupled voltage follower and design its steps. **(06 Marks)**

b. A capacitor coupled non-inverting amplifier using 741 op-Amp has $A_v = 100$ & $V_o = 5$ V. The load resistance is 10 kΩ and the lower cut-off frequency is to be 100 Hz. Design a suitable circuit. **(08 Marks)**

c. Explain inverting A.C. Amplifier with neat diagram and mention its design steps using only single-supply op-Amp. **(06 Marks)**

3 a. Explain phase lead and phase lag compensation methods along with frequency response. **(08 Marks)**

b. Consider a 741 op-Amp with slew rate of 0.6 V/μs is used as a voltage follower. Calculate (i) The slew rate limited cut-off frequency if the sine wave o/p is 6V. (ii) Calculate the maximum peak value of the sinusoidal o/p voltage, if the circuit operator with unity gain cut-off frequency of 800 kHz. (iii) Calculate the maximum peak value of the o/p voltage, if the upper cut-off frequency is 8 kHz. **(06 Marks)**

c. List the precautions that should be used for op-Amp circuit stability. **(06 Marks)**

4 a. Draw the circuit of an instrumentation amplifier and explain how the voltage gain can be varied? **(10 Marks)**

b. Discuss the operation of precision full wave rectifier circuit using bipolar op-Amp. **(10 Marks)**

PART – B

5 a. Explain the operation of op-Amp sample and hold circuit with signal, control and output waveforms. **(08 Marks)**

b. Draw a neat sketch and explain the working of wein bridge oscillator circuit. **(06 Marks)**

c. Explain frequency doubler technique using op-Amp. **(06 Marks)**

6 a. Sketch the circuit of a second order low lass filter and explain its working. **(07 Marks)**

b. An INV Schmitt trigger circuit is to have UTP = 0 V and LTP = 2.5 V. Design a suitable circuit using a bipolar op-Amp with ± / 15 V supply. **(06 Marks)**

c. Sketch the circuit of an op-Amp astable multivibrator and show the voltage waveforms at various points and explain its operation. **(07 Marks)**

7 a. Explain the terms line, load regulation and ripple rejection for a dc voltage regulator. **(06 Marks)**

b. Design a voltage regulator using IC723 to get a voltage o/p of 25 V. **(08 Marks)**

c. Mention the salient features of a 723 regulator. **(06 Marks)**

8 a. Explain Mono-stable multi-vibrator using 555 Ic ? **(06 Marks)**

b. With a neat sketch, explain the working of a R-2R ladder network. **(08 Marks)**

c. With block diagram, explain successive approximation ADC. **(06 Marks)**

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MATDIP401

Fourth Semester B.E. Degree Examination, June / July 2014
Advanced Mathematics – II

Time: 3 hrs. Max. Marks:100

Note: ***Answer any FIVE full questions.***

1 a. Define direction cosine and direction ratio of a line. Hence show that $l^2 + m^2 + n^2 = 1$. **(06 Marks)**

b. For any cube show that angle between any two diagonals is $\cos^{-1}\left(\frac{1}{3}\right)$. **(07 Marks)**

c. Define plane. Derive equation of plane in general form. **(07 Marks)**

2 a. Find equation of plane passing through A(-1, 1, 1), B(1, -1, 1) and perpendicular to plane $x + 2y + 2z - 5 = 0$ **(06 Marks)**

b. Show that the line $\frac{x-4}{2} = \frac{y-2}{3} = \frac{z-3}{10}$ is parallel to plane $2x + 2y - z = 6$. Find distance between them. **(07 Marks)**

c. Show that lines $\frac{x-5}{4} = \frac{y-7}{4} = \frac{z+3}{-5}$ and $\frac{x-8}{7} = \frac{y-4}{1} = \frac{z-5}{3}$ are coplanar. Find point of intersection. **(07 Marks)**

3 a. Find sine and cosine of angle between the vectors $4\mathbf{i} + 3\mathbf{j} + \mathbf{k}$, $2\mathbf{i} - \mathbf{j} + 2\mathbf{k}$. **(06 Marks)**

b. Show that points (4, 5, -1), (0, -1, -1), (3, 9, 4), (-4, 4, 4) are coplanar using vector method. **(07 Marks)**

c. Prove that $\left[\vec{a}+\vec{b}, \vec{b}+\vec{c}, \vec{c}+\vec{a}\right] = 2\left[\vec{a}, \vec{b}, \vec{c}\right]$. **(07 Marks)**

4 a. A particle moves along the curve $x = t^3+1$, $y = t^2$, $z = 2t + 5$. Find components of its velocity and acceleration at $t = 1$ in the direction $\mathbf{i} + \mathbf{j} + 3\mathbf{k}$ **(06 Marks)**

b. Find directional derivative of $x^2 + y^2 + 4xyz$ at (1, -2, 2) in the direction $2\mathbf{i} - 2\mathbf{j} + \mathbf{k}$. **(07 Marks)**

c. Show that $\text{grad}\left(\frac{1}{r}\right) = -\frac{\vec{r}}{r^2}$. **(07 Marks)**

5 a. For any scalar function ϕ show that $\text{curl}(\text{grad}\phi) = 0$. **(06 Marks)**

b. If $\vec{F} = \text{grad}\phi$, $\phi = x^2+y^2+z^2+xyz$, find $\nabla \cdot \left(\vec{F}\right)$ and $\nabla \times \left(\vec{F}\right)$ at (1, 1, 1). **(07 Marks)**

c. Find a, b, c so that $\vec{F} = (x + y + az)\mathbf{i} + (x + cy + 2z)\mathbf{j} + (x + 2y - z)\mathbf{k}$ is irrotational. Find scalar function. **(07 Marks)**

6 a. Find Laplace Transform if t^n and hence find $L\left(\frac{1}{t^{\frac{1}{2}}}\right)$. **(06 Marks)**

b. Find $L\left[e^{2t}\cos 3t + e^{-t}\sin 2t + t\sin t\right]$. **(07 Marks)**

c. Find $L\left[\frac{e^{t}(\cos 3t - \cos t)}{t}\right]$. **(07 Marks)**

7 a. Find $L[\sin t \ \sin 2t \ \sin 3t]$. **(06 Marks)**

b. Find $L[f(t)]$ where $f(t) = \begin{cases} 1 & 0 < t \le 1 \\ t & 1 < t \le 2 \\ t^2 & t > 2 \end{cases}$. **(07 Marks)**

c. Find $L^{-1}\left\{\log\sqrt{\frac{s+a}{s-b}}\right\}$. **(07 Marks)**

8 a. Find $L^{-1}\left\{\frac{2s^2 - 6s + 5}{s^3 - 6s^2 + 11s - 6}\right\}$. **(10 Marks)**

b. Solve by Laplace transformation, $\frac{d^2y}{dt^2} + 7\frac{dy}{dt} + 10y = 4e^{-3t}$, given $y(0) = 0, y'(0) = -1$. **(10 Marks)**

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