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10MAT41

Fourth Semester B.E. Degree Examination, June/July 2017
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. Find y(0.1) by using Taylor's series method, given that $y' = \sqrt{x^2 + y}$, $y(0) = 0.8$. Consider upto third order derivative terms. **(06 Marks)**

b. Given : $\frac{dy}{dx} = \frac{1}{1+x^2} - 2y^2$, y(0) = 0. Find y(0.5), by taking h = 0.25, using Euler's modified method. **(07 Marks)**

c. If $y' = \frac{1}{x+y}$, $y(0) = 2.0000$, $y(0.2) = 2.0933$, $y(0.4) = 2.1755$, $y(0.6) = 2.2493$, find y(0.8) by using Adams-Bash forth method. **(07 Marks)**

2 a. Using the Picard's method, obtain the 2nd order approximate solution of the problem at x = 0.2, $\frac{dy}{dx} = x + yz$; $\frac{dz}{dx} = y + zx$, $y(0) = 1$ and $z(0) = -1$. **(06 Marks)**

b. Using the R-K method, find the solution at x = 0.1 of an equation; $y'' - x^2y' - 2xy - 1 = 0$ with the conditions y(0) = 1, y'(0) = 0 and step size 0.1. **(07 Marks)**

c. Given that $y'' + xy = 0$, $y(0) = 1$, $y(0.1) = 1.0998$, $y(0.2) = 1.1987$, $y(0.3) = 1.2955$, $y'(0) = 1$, $y'(0.1) = 0.9946$, $y'(0.2) = 0.9773$, $y'(0.3) = 0.946$, find y(0.4), using Milne's method. (Apply corrector formula only once). **(07 Marks)**

3 a. Derive Cauchy-Riemann equations in the polar form. **(06 Marks)**

b. If $f(z) = u + iv$ is an analytic function, then prove that the family of curves; $u(x, y) = C_1$, $v(x, y) = C_2$, C_1 and C_2 being constants, interfect orthogonally. Is the converse true? Justify your answer. **(07 Marks)**

c. In a two dimensional fluid flow; if the velocity potential is $e^{-x}\cos y + xy$, find the stream function. **(07 Marks)**

4 a. Find the bilinear transformation which maps the points z = 1, i, -1 onto the points w = i, 0, -i. Also find the invariant points. **(06 Marks)**

b. Discuss the transformation, $w = z + \frac{K^2}{z}$, where $z \neq 0$, $K \neq 0$. **(07 Marks)**

c. State and prove the Cauchy's theorem. **(07 Marks)**

PART – B

5 a. Obtain the series solution of Bessel's differential equation. **(07 Marks)**

b. Derive the Rodrigue's formula. **(07 Marks)**

c. Express the polynomial $2x^3 - x^2 - 3x + 2$ in terms of Legendre polynomials. **(06 Marks)**

6 a. 'A' can hit a target 3 times in 5 shots, 'B' 2 times in 5 shots and 'C' 3 times in 4 shots. They fire a volley. Find the probability that (i) 2 shots hit (ii) at least 2 shots hit. **(06 Marks)**

b. If A and B are events with $P(A) = \frac{1}{2}$, $P(A \cup B) = \frac{3}{4}$, $P(\overline{B}) = \frac{5}{8}$ find $P(A \cap B)$, $P(\overline{A} \cap \overline{B})$, $P(\overline{A} \cup \overline{B})$ and $P(\overline{A} \cap B)$. **(07 Marks)**

c. State and prove Baye's theorem. **(07 Marks)**

7 a. (i) Is the function defined as follows a density function? $f(x) = e^{-x}, x \geq 0$, $f(x) = 0$, $x < 0$.

(ii) If so, determine the probability that the variate having this density will fall in the interval (1, 2).

(iii) Also find the cumulative probability function F(2). **(06 Marks)**

b. Obtain the mean and standard deviation of the Poisson distribution. **(07 Marks)**

c. The life of an electric bulb is normally distributed with mean life of 200 hours and S.D. of 60 hours. Out of 2500 bulbs, find the number of bulbs which are likely to last between 1900 and 2100 hours. Given that $P(0 < Z < 1.67) = 0.4525$. **(07 Marks)**

8 a. Explain the following terms briefly: (i) Null hypothesis (ii) Type I and Type II errors (iii) Confidence limits. **(06 Marks)**

b. Two types of batteries are tested for their length of life and the following results are obtained:

Battery A : $n_1 = 10$, $\bar{x}_1 = 500$ hrs, $\sigma_1^2 = 100$

Battery B : $n_2 = 10$, $\bar{x}_2 = 560$ hrs, $\sigma_2^2 = 121$.

Find students 't' and test whether there is a significant difference in the two means. ($t_{0.05} = 2.10$ and $t_{0.01} = 2.88$). **(07 Marks)**

c. Genetic theory states that children having one parent of blood type M and the other of blood type N will always be one of the three types M, MN, N and that the proportions of these types will on an average be 1 : 2 : 1. A report states that out of 300 children having one M parent and one N parent, 30% are found to be of type M, 45% of type MN and the remainder of type N. Test the theory by ψ^2 (chi-square) test. **(07 Marks)**

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10ES42

Fourth Semester B.E. Degree Examination, June/July 2017
Microcontrollers

Time: 3 hrs. Max. Marks:100

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

PART – A

1 a. Give comparison between microprocessor and microcontroller. **(06 Marks)**

b. Explain with neat diagram, Harvard architecture and Van-Neumann architecture. **(06 Marks)**

c. With the help of block diagram, list the specific features of 8051 microcontroller. **(08 Marks)**

2 a. Explain the following instructions with suitable examples:
i) MOVX A, @dptr ii) ACALL Target iii) DJNZ R1, up **(06 Marks)**

b. Differentiate between jump and CALL instructions. **(06 Marks)**

c. Write an assembly language program with comments using 8051 mnemonics to convert ASCII to hexadecimal. **(08 Marks)**

3 a. Briefly explain the different assembler directives used in an assembly language program. **(04 Marks)**

b. Write an ALP to find the number of negative and positive numbers in a given array of ten bytes of data. The number is available from memory location 8000 h. **(08 Marks)**

c. Write an 8051 software time delay subroutine to generate a time delay of 1 second when called. Assume crystal frequency as 11.0592 MHz. Show delay calculations. Do not use timers? **(08 Marks)**

4 a. Explain with a diagram, how the DAC 0808 can be interfaced to 8051 microcontroller. Write an 8051 C program to create the triangular wave. **(10 Marks)**

b. With a neat diagram show how a stepper motor is interfaced to 8051. Write a program to rotate it continuously. **(10 Marks)**

PART – B

5 a. Differentiate between a counter and timer. Explain the timer modes of operation in 8051. **(04 Marks)**

b. Assuming that XTAL = 11.0592 MHz, write a program to generate a square wave of 2 kHz frequency on pin P1.5. Use timer 1 and mode 1 operation. Duty cycle = 50%. **(08 Marks)**

c. Explain TMOD and TCON registers with its bit pattern. **(08 Marks)**

6 a. Explain briefly the interrupts of 8051, indicate their vector addresses. **(05 Marks)**

b. Explain the format of SCON register in details. **(05 Marks)**

c. Write a program with proper comments to transfer the message "YES" serially at 9600 baud rate, 8 bit data, 1 stop bit. Do this continuously. **(10 Marks)**

7 a. Write the steps required for programming 8051 to receive data serially. **(08 Marks)**

b. With a block schematic, explain the features of 8255 PPI chip and its mode of operation. **(06 Marks)**

c. What is the need for serial communication? Explain half duplex and full duplex transmission. **(06 Marks)**

8 a. Explain the architecture of MSP 430 CPU with its internal block schematic. **(10 Marks)**

b. Mention the features and functions of the watch-dog timer and explain. **(10 Marks)**

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10ES43

Fourth Semester B.E. Degree Examination, June/July 2017
Control System

Time: 3 hrs. Max. Marks:100

Note: *1. Answer any FIVE full questions, selecting atleast TWO questions from each part.*
2. Graph and semi log required.

PART – A

1 a. Write down the differential equations governing the system below and write the force voltage analogy circuit. **(10 Marks)**

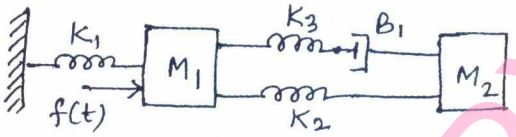

Fig.Q1(a)

b. For the Fig.Q1(b). Derive the expression for the TF : $\frac{Q_1(s)}{T_1(s)} = \frac{1}{s(s^2 J_{eq} + B_{eq})}$. **(10 Marks)**

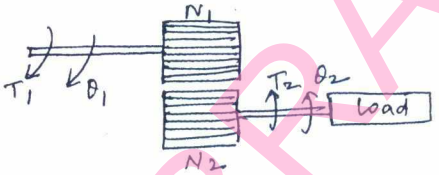

Fig.Q1(b)

2 a. Find the TF of the system by using block diagram reduction method. **(10 Marks)**

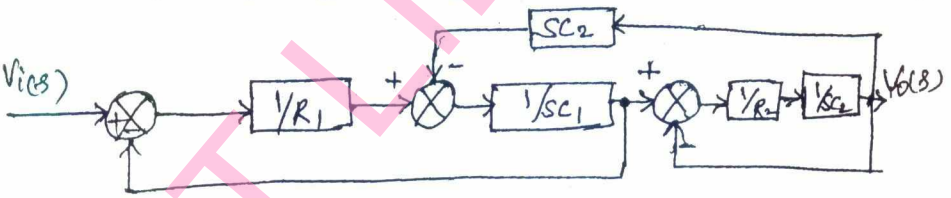

Fig.Q2(a)

b. Find the C/R for the following system using Mason's gain formula. **(10 Marks)**

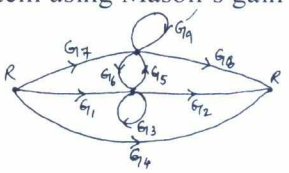

Fig.Q2(b)

3 a. Give the definition for the following transient response of a control systems to a unit step input interms of time domino specifications.
i) Delay time, t_d ii) Rise time, t_r iii) Peak time, t_p iv) Maximum overshoot Mp v) Settling time, t_s with equations. **(10 Marks)**

b. A closed loop servo is represented by the differential equation : $\frac{d^2c}{dt^2} + \frac{8dc}{dt} = 64e$ where 'c' is the displacement of the output Shaft 'r' is the displacement of the input shaft and e = r – c, determine undamped natural frequency, damping ratio. **(10 Marks)**

4 a. A system with oscillating frequency w, if it has poles at s = ±jw, no poles to the right half of the S plane. Determine the value of 'K' and so that the system is shown below oscillates at a frequency of 2 rad/sec. **(10 Marks)**

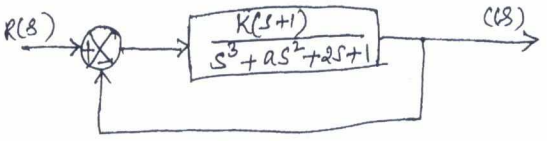

Fig.Q4(a)

b. The open loop transfer function of servo system with unity feedback is $G(s) = \frac{10}{s(0.1s+1)}$. Evaluate the static error constant of the system. Obtain the steady – state error of the system, when subjected to an input given by the polynomial $r(t) = a_0 + a_1 t + \frac{a_2}{2} t^2$. **(10 Marks)**

PART – B

5 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.
(20 Marks)

6 Sketch the Nyquist plot for the open loop transfer function :

$G(s)H(s) = \frac{10}{(s+2)(s+4)}$. Determine the stability of the closed loop system by Nyquist criterion. **(20 Marks)**

7 The open loop transfer function of unity feedback system is : $G(s) = \frac{K}{s(s+1)(s+10)}$.

Draw the Bode plot and determine :
i) Limiting value of K for the system to be stable
ii) The value of 'K' for gain margin of 7dB
iii) The value of K for phase margin of 40° $G(s) = \frac{k}{s(s+1)(s+10)}$. **(20 Marks)**

8 a. Write the state equation for the network shown : **(10 Marks)**

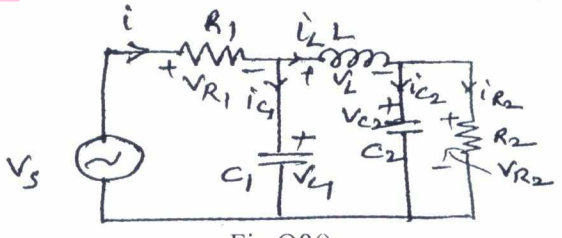

Fig.Q8()

b. Obtain the characteristic equation of the matrix :

$$A = \begin{bmatrix} 0 & 1 & 0 \\ 3 & 0 & 2 \\ -12 & -7 & -6 \end{bmatrix}.$$ **(10 Marks)**

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10EE44

Fourth Semester B.E. Degree Examination, June/July 2017
Field Theory

Time: 3 hrs. Max. Marks:100

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

PART – A

1 a. State and explain Coulomb's law in vector form. **(06 Marks)**

b. Four point charges, each of 25 nC are kept at the corners of a square of 5m. Find out the value of the charge that should be kept at the centre of the square to keep all the above charges stable at the corners of the square. **(08 Marks)**

c. State and explain Gauss law. Find out electric field intensity at a distance 'r' from an infinite line charge using Gauss law. **(06 Marks)**

2 a. Prove $E = -\nabla V$ by considering $E.\Delta l$. **(06 Marks)**

b. Find the capacitance per unit length of a cable having inner radius 'a' and outer radius 'b' by finding $\vec{E}$ and V of the cable. Use Gauss law for finding 'E' of the cable. **(06 Marks)**

c. The lines of electric field make an angle of 45° in air at the boundary between Glass ($\epsilon_r = 5$) and air ($\epsilon_r = 1$). If the electrical flux density in air (Dr) is 0.5 $\mu C/m^2$, determine the orientation and magnitude of D_g in glass. **(08 Marks)**

3 a. Derive Poisson's and Laplace equation. **(06 Marks)**

b. Determine voltage at any given point of the region between two concentric spheres of radius 'a' (inner sphere) and radius 'b' (outer sphere) using Laplace equation. Assume that inner sphere is having a potential of 100 volts and outer sphere is earthed. **(08 Marks)**

c. Find out whether $V = 2x^2 - 3y^2 + z^2$ satisfies Laplace equation or not. **(06 Marks)**

4 a. Derive Stokes theorem $\int_S (\nabla \times H) \cdot \Delta S = \oint_\ell H \cdot d\ell$ after determining $\nabla \times H = J$ by considering elemental rectangular loop in xy plane and generalizing for other. **(08 Marks)**

b. Determine magnetic field intensity and magnetic flux density of a coaxial cylinder by ampere circuital law. Radius of inner conductor is 'a' and carries a current 'I'. Outer conductor of radius 'b' is earthed. Assume that the thickness of the outer cylinder is negligible. **(06 Marks)**

c. Determine the magnetic field intensity at the centre of a square loop of 2m length carrying a current of 10A. **(06 Marks)**

PART – B

5 a. Derive an expression for the force between the current loops. **(06 Marks)**

b. A conductor length of 2.5 m located at z = 0, x = 4m carries a current of 12A in $-\hat{a}y$ direction. Find the uniform 'B' in the region if the force on the conductor is 1.2×10^{-2} N in the direction $\frac{-\hat{a}x + \hat{a}z}{\sqrt{2}}$. **(08 Marks)**

c. An aircored torroid has a c/s of 10 cm^2, a mean radius of 15 cm and is wound with 500 turns carries a current of 5A. Find the magnetic field intensity at the mean radius. **(06 Marks)**

6 a. Write the Maxwell's equation in both point and integral form. **(06 Marks)**

b. Derive an expression for open circuit voltage of a faraday disc generator. The disc has a radius 'a' and rotate at a constant angular velocity 'w' rad/sec in a magnetic field of 'B' $\hat{a}z$ wb/m^2. The brushes are placed at the axis and rim of the disc. **(06 Marks)**

c. Explain what is meant by displacement current. What is meant by retarded potential? **(08 Marks)**

7 a. State and prove Poynting theorem. **(06 Marks)**

b. If the electric field strength is equal to 50 cos(wt – βy) $\hat{a}z$ V/m determine the displacement current density. If the same field exists in a medium whose conductivity is given by 2×10^3 ℧/cm, find the conduction current density **(08 Marks)**

c. Derive the equation $\nabla^2\vec{E} - \mu \in \frac{\partial^2 E}{\partial t^2} = \mu\frac{\partial \vec{J}}{\partial t} + \nabla\left(\frac{\rho V}{t}\right)$ from Maxwell's equations. **(06 Marks)**

8 a. Explain skin effect and its significance. **(06 Marks)**

b. With necessary expression explain standing wave ratio (SWR). **(06 Marks)**

c. Discuss wave propagation in lossy dielectric. **(08 Marks)**

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10EE45

Fourth Semester B.E. Degree Examination, June/July 2017
Power Electronics

Time: 3 hrs. Max. Marks:100

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

PART – A

1 a. List and explain the different types of power electronic converters. Show their I/O characteristics. **(08 Marks)**

b. What are the peripheral effects of power converters? **(04 Marks)**

c. What is the necessity of base drive control high power transistor? Explain proportional base and anti-saturation control. **(08 Marks)**

2 a. With necessary waveforms. Explain the switching performance of power BJT. **(07 Marks)**

b. With relevant diagrams, discuss the methods of providing isolation of Gate/base drive control in power circuits and what are its limitation? **(07 Marks)**

c. In the power BJT circuit has β in the range of 10 to 25. If V_{CC} = 230V, R_c = 12Ω, V_{BB} = 15V, V_{CES} = 1.2V and V_{BES} = 1.8V. Calculate :
i) The value of R_B required to move the transistor into saturation with an ODF of 6.
ii) Forced beta β_f
iii) Total power dissipation. **(06 Marks)**

3 a. With a neat sketch, explain the static VI characteristics of an SCR. What are the significances? Define the latching current, holding current and break over voltage. **(08 Marks)**

b. With the help of two transistor model of an SCR, Derive the expression of anode current. Explain the switching action and significance of the Gate control. **(08 Marks)**

c. The SCR in the circuit of Fig Q3(c) has a latching current of 50mA and is triggered by a gate pulse width 50 µ.sec. Show that without resistance R^1 thyristor will fail to remain ON when the gating pulse ends. Also find the maximum value of R^1 to ensure firing. The ON state voltage drop of an SCR can be neglected. **(04 Marks)**

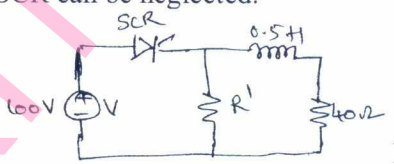

Fig Q3 (c)

4 a. Define commutation? What are the necessary conditions of commutation? Mention the different types of commutation circuits. **(08 Marks)**

b. With necessary circuit and waveforms, explain complementary commutation scheme. Derive an expression for t_c. **(08 Marks)**

c. The circuit of Fig Q4(c) employing class –C commutation has V_s = 200V, R_1 = 10Ω, R_2 = 100Ω. Determine :
i) Peak value of the current through T_1
ii) Value of capacitor C, if each thyristor has turn off time of 40 µ.sec. Take factor of safety as 2. **(04 Marks)**

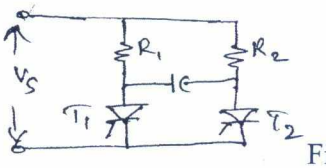

Fig Q4(c)

PART – B

5 a. What is the use of freewheeling diode in the converters? Explain the principle of operation of single phase FWR feeding with R-L loads. Draw the relevant sketch and waveforms. **(07 Marks)**

b. With neat circuit and waveforms, explain the working of three phase half wave converter. Derive the expression for $V_o(av)$ for resistive load. **(07 Marks)**

c. In the three phase half wave converter has a line – line voltage of 415V, 50Hz, the load is purely resistive load with R = 15Ω. If the average load voltage is 50% of maximum possible average output voltage. Determine :

i) The delay angle α
ii) Average values of output current
iii) The average and rms values of thyristor current. **(06 Marks)**

6 a. What is chopper? Classify the different types of choppers with circuit diagrams. **(06 Marks)**

b. With the help of circuit and quadrilateral diagrams, explain the working of a class E chopper. Mention the devices that give path for the current in each quadrant. **(08 Marks)**

c. In the chopper circuit of Fig Q6(c). The average output voltage is 109V. The voltage drop across the chopper switch when it is ON ie V_s = 2V. If the load resistance R = 10Ω, f = 1.5 KHz and duty ratio δ = 50%. Calculate :

i) The rms output voltage
ii) The dc input to the chopper
iii) Chopper efficiency
iv) Input resistance of chopper. **(06 Marks)**

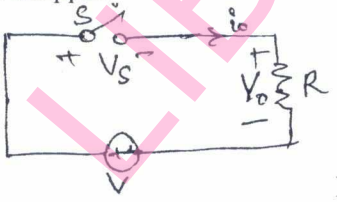

Fig Q6(c)

7 a. What do you mean by inverters? Explain the operation of single phase full bridge inverter. Draw the load current waveforms for R, R-L load and RLC loads. **(08 Marks)**

b. Explain the operation of a three phase transistorized inverter in 180° conduction angle mode with star connected Resistive load. **(08 Marks)**

c. Explain voltage control of single phase inverter by sinusoidal pulse width modulation technique. Draw relevant forms. **(04 Marks)**

8 a. What is AC voltage regulator (controller)? With the help of waveforms explain ON-OFF control and phase control. **(07 Marks)**

b. Explain the operation of a single phase bidirectional controller with resistive load. Obtain the expression for rms value of output voltage. Show their waveforms. **(08 Marks)**

c. Write a note on electromagnetic compatibility effect on power electronic converters. **(05 Marks)**

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10EE46

Fourth Semester B.E. Degree Examination, June/July 2017
Transformers and Induction Machines

Time: 3 hrs. Max. Marks:100

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

PART – A

1 a. With phasor diagram, explain the operation of :
i) Ideal transformer on no load
ii) Practical transformer supplying a lagging load. **(10 Marks)**

b. Write a note on current inrush phenomena in transformers. **(05 Marks)**

c. A single phase transformer with a ratio of 440V/110V takes a no load current of 5 Amps at 0.2pf lagging. If the secondary supplies a current of 120 Amps at a pf of 0.8 lagging, estimate the current taken by the primary. **(05 Marks)**

2 a. For a two winding transformer, derive an expression for the total ohmic loss in terms of the equivalent resistance refereed to either side. **(05 Marks)**

b. Derive the condition for : i) maximum voltage regulation and ii) zero voltage regulation of a transformer. **(05 Marks)**

c. Two 100 KW transformers, each has a maximum efficiency of 98%, but in one of the transformer the maximum efficiency occurs at full load while in the other, it occurs at half load. Each transformer is on full load for 4 hours, on half load for 6 hours and on one–tenth load for 14 hours per day. Determine the all-day efficiency of each transformer. **(10 Marks)**

3 a. Derive an expression for saving of copper when an auto transformer is used to supply a load instead of a two winding transformer and hence mention the advantages and limitations of an auto transformer. **(10 Marks)**

b. Two single phase transformers A and B of equal voltage ratio are operating in parallel to supply a load of 1000 Amps at 0.8pf lag. The equivalent impedance of the two transformers are $(2 + j3)\ \Omega$ and $(2.5 + j5)\ \Omega$ respectively. Calculate the current supplied by each transformer and the ratio of the KW output of the two transformers. **(10 Marks)**

4 a. What do you mean by open delta connection? When it is used? **(05 Marks)**

b. A 3-phase transformer bank is used to step-down the voltage of a 3-phase, 6600V transmission line. if the primary line current is 10A, calculate the secondary line voltage, line current and output KVA for : i) star/delta and ii) delta/star connections the turns ratio is 12. Neglect losses. **(05 Marks)**

c. Two single phase furnaces A and B are supplied at 100 volts by means of a Scott-connected transformer from a 3-phase 6600volts system. The voltage of furnace A is leading. Calculate the line currents on the 3-phase side, when the furnace A takes 400 KW at 0.707 pf lagging and B takes 800 KW at unity pf. **(10 Marks)**

PART – B

5 a. Explain principle of operation of a 3-phase induction motor. **(05 Marks)**

b. Draw and explain the Torque-slip characteristic of 3-phase induction motor covering motoring, generating and braking regions of operation. **(05 Marks)**

c. A 4pole, 50Hz, 10h-p motor has, at rated voltage and frequency, a starting torque of 160% and a maximum torque of 200% of full-load torque. Determine : i) full-load speed ii) speed at maximum torque. **(10 Marks)**

6 a. Develop the equivalent circuit of a 3-phase induction motor and draw its phasor diagram and explain. **(10 Marks)**

b. A 220V, 3-phase, 4-pole, 50Hz star-connected induction motor is rated 5hp the equivalent circuit parameters are : $R_1 = 0.45\Omega$, $x_1 = 0.8\Omega$; $R_2^1 = 0.4\Omega$, $x_2^1 = 0.8\Omega$. $B_0 = -1/30$ mho. The stator core loss is 50W and rotational loss is 150W. For a slip of 0.04, find : i) input current ii) pf iii) air gap power iv) mechanical power v) efficiency. **(10 Marks)**

7 Write brief notes on :

a. Double cage induction motor

b. Deep bar rotor

c. Induction generator and its applications

d. Cogging and crawling in 3-phase induction motors. **(20 Marks)**

8 a. What are the different methods of starting an induction motor? Explain star Delta starting of induction motor. **(05 Marks)**

b. A 3-phse squirrel cage induction motor has a short circuit $I_{sc} = 5I_f$ (I_f = full load current). Find the starting torque as a percentage of full load torque if the motor is started by : i) direct switching to the supply ii) a star-delta starter is used iii) an auto transformer is used iv) A resistance in the stator circuit. the starting current in iii) and iv) is 2.5 times the full load current and full load slip = 4%. **(10 Marks)**

c. Why single phase induction motors are not self starting? **(05 Marks)**

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MATDIP401

Fourth Semester B.E. Degree Examination, June/July 2017
Advanced Mathematics – II

Time: 3 hrs. Max. Marks:100

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

1 a. Find the angle between any two diagonals of a cube. **(06 Marks)**

b. Find the angle between two lines whose direction cosines are given by $\ell + 3m + 5n = 0$ and $2mn - 6n\ell - 5\ell m = 0$. **(07 Marks)**

c. Find the coordinates of the foot of the perpendicular from A(1, 1, 1) to the line joining the points B(1, 4, 6) and C(5, 4, 4). **(07 Marks)**

2 a. Find the equation of the plane through (2, -1, 6) and (1, -2, 4) and perpendicular to the plane $x - 2y - 2z + 9 = 0$. **(06 Marks)**

b. Find the equation of a straight line through (7, 2, -3) and perpendicular to each of the lines. $\frac{x-1}{3} = \frac{y-3}{4} = \frac{z-4}{5}$ and $\frac{x+2}{4} = \frac{y-3}{5} = \frac{z-4}{6}$. **(07 Marks)**

c. Find the angle between the planes $x - y + z - 6 = 0$ and $2x + 3y + z + 5 = 0$. **(07 Marks)**

3 a. If $\vec{a}$, $\vec{b}$ and $\vec{c}$ are any three vectors then prove that

$$\vec{a} \times \left(\vec{b} \times \vec{c}\right) = \left(\vec{a} \cdot \vec{c}\right)\vec{b} - \left(\vec{a} \cdot \vec{b}\right)\vec{c}$$ **(06 Marks)**

b. If $\vec{A} = 4i + 3j + k$, $\vec{B} = 2i - j + 2k$ find a unit vector N perpendicular to the vectors $\vec{A}$ and $\vec{B}$ also show that $\vec{A}$ is not perpendicular to $\vec{B}$. **(07 Marks)**

c. Find the value of λ so that the points A(-1, 4, -3), B(3, 2, -5), C(-3, 8, -5) and D(-3, λ, 1) lie on the same plane. **(07 Marks)**

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

b. Find the angle between tangents to the curve $x = t^2 + 1$, $y = 4t - 3$, $z = 2t^2 - 6t$ at $t = 1$ and $t = 2$. **(07 Marks)**

c. Find the directional derivative of $x^2yz + 4xz^2$ at (1, -2, -1) in the direction of $2i - j - 2k$. **(07 Marks)**

5 a. Prove that $\text{div}(\text{curl}\,\vec{A}) = 0$. **(06 Marks)**

b. Find the divergence and curl of the vector.

$\vec{F} = (xyz + y^2z)i + (3x^2y + y^2z)j + (xz^2 - y^2z)k$ **(07 Marks)**

c. Find the constants a, b, c so that the vector,

$\vec{F} = (x + 2y + az)i + (bx - 3y - z)j + (4x + cy + 2z)k$ is irrotational. **(07 Marks)**

6 Find :

a. $L[\sin 5t \sin 3t]$ **(05 Marks)**

b. $L[te^{8t} \cos 2t]$ **(05 Marks)**

c. $L\left[\frac{1-e^{at}}{t}\right]$ **(05 Marks)**

d. $L\left[\int_0^t e^{2t} \frac{\sin at}{t} dt\right]$ **(05 Marks)**

7 a. Find $L^{-1}\left[\frac{2s-1}{s^2+2s+17}\right]$. **(05 Marks)**

b. Find $L^{-1}\left[\frac{s+1}{(s-1)^2(s+2)}\right]$. **(05 Marks)**

c. Find $L^{-1}\left[\cot^{-1}\left(\frac{s}{a}\right)\right]$. **(05 Marks)**

d. Using convolution theorem evaluate $L^{-1}\left[\frac{s}{(s+2)(s^2+9)}\right]$. **(05 Marks)**

8 a. Using Laplace transforms, solve $\frac{d^2y}{dt^2} + 2\frac{dy}{dt} - 3y = \sin t$ given $y(0) = y'(0) = 0$. **(10 Marks)**

b. Using Laplace transforms, solve $\frac{dx}{dt} + y = \sin t$, $\frac{dy}{dt} + x = \cos t$, given x = 2, y = 0 when $t = 0$. **(10 Marks)**

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