BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA
Sub: HUM 135 (English)

Full Marks : 210 Time : 3 Hours

The figures in the margin indicate full marks.
USE SEPARATE SCRIPTS FOR EACH SECTION

SECTION – A

There are FOUR questions in this section. Answer any THREE questions including Q. No. 5 as compulsory.

1. (a) Explain with reference to the context any two of the following:
(i) People were attracted to him as bees are attracted to cosmos or dahlia stalks.
(ii) Philosophy, at all events now, was a business for the experts.
(iii) ... I was hated by large numbers of people the only time in my life that I have been important enough for this to happen to me.

(b) Attempt any one of the following:

(i) Do you think that "Shooting an Elephant" is a story of imperialism? substantiate your answer.
(ii) Comment on the "irony and humour" in "An Astrologer's Day".

(c) Answer any three of the following questions:

(i) How did Ralph organize the children on the deserted mountain? Point out some leadership qualities in him.
(ii) Why didn't the writer give any name for the astrologer?
(iii) Why do you think that the writer of "Shooting an Elephant" narrated the story in both past and present tenses?
(iv) What message do you get from your study of "The Use of Philosophy"?
(v) What does the 'beastie' symbolize in "Fire on the Mountain"?

2. (a) Recast and correct any ten of the following sentences:

(i) He has good knowledges of history.
(ii) His illusion to my failure was clear.
(iii) We hanged the picture on the wall.
(iv) Nipa was an alumnus of BUET.
(v) That medicine makes miracles.
(vi) They made less mistakes with the new calculating machine.
(vii) I am going to cut my hair.
(viii) John tore up his coat on a nail.
(ix) I have not seen him today morning.
(x) This is the kind of a day that makes me lazy.
(xi) The data (facts) is incorrect.
(xii) Hasan is seldom ever on time for his dinners.

Contd ............ P/2
(b) Give meanings of and then make sentences with any ten of the following words:
Accumulate, Abate, Condone, Discern, Elusive, Furtive, Homage, Identical, Meddle, Ordeal, Palatable, Prevalent.

3. Amplify any one of the following ideas:
   (a) Only the actions of the just smell sweet, and blossom in their dust.
   (b) He that is humble, ever shall Have God to be his guide.

4. Write a précis of the following passage with a suitable title:

   Education is the process by which our mind develops through formal learning at an institution like school, college or university. It is mental and intellectual training, which provides opportunities of growth and helps to overcome impediments and obstacles to progress. Again, the purpose of education is to enlighten the individual and to develop his/her capacity to the limit. It is also the business of education to train individuals to make the right choices to go ahead. It ennobles our mind and refines our sensibility. It also broadens our outlook and helps us become aware of our rights and responsibilities.

   According to Newman, education gives a man a clear conscious view of his own opinions and judgements, a truth in developing them, an eloquence in expressing them and a force in using them. Therefore, it is often compared to light, which removes the darkness of ignorance and helps us distinguish between right and wrong. Julius Nyerere, President of Tanzania, in 1974 said at an international conference that the primary purpose of education is the liberation of man from the restrictions of habits and attitudes, which limit his humanity. He further said, education should promote humanity and universal brotherhood, and that it could be used as a catalyst for a change for the better. How right he was!

SECTION - B

There are FOUR questions in this section. Answer any THREE questions including Q. No. 5 as compulsory.

5. Read the passage carefully and answer the questions that follow:

   Since when have I started calling this semi-summer the season of watermelon, I do not know. It has been occurring to me in the last few years, when out of nowhere, suddenly my walls home get filled with watermelons at one of the busiest footpath markets, in Farmgate. The juicy red pyramids that are put to raise the potential customers within one rarely fail.

   Recently, I started getting a similar kind of aura at my campus corridors, as a group of students of our university were found determined enough to wear red and green throughout the whole month of March. I found it quite interesting and thought of having a talk with them.

   Contd ......... P/3
One fine morning, I found my cubicle filled up with super-fine laughter of the watermeloned girls. They, however, came up with a humble request to join them by being a watermelon myself on any of the weekdays that I would prefer; eventually I would end up at the tailors that evening.

But my first response or rather a query to them was "why"? They seemed a little hurt. My "why?" brought a "just-fell-from-the-sky" expression on their faces, all of them started talking almost at the same time and my tiny cubic started filling up with words like --- freedom, independence, green Bengal, red sun/blood, martyrs --- and 26th March. That evening, I also noticed that the tailors' are also boiling with 'nationalistic enthusiasm', but they denied taking any order as they were too busy with sewing the red and greens -- shelwar-kameej-dupatta-punjabis. I hope the spirit of Independence will not be trapped within the colours only, let's surpass the season of watermelon, let us live the spirit everyday as we grow. I do not know if such enthusiasms are sticky enough to hold on the attires or not. It is cosier to enjoy the evening in a blind lane of Farmgate with a bowl of watermelon after a hot-long-semi-summer-walk and a fictive-nationalism-talk with my students... 'um lovin' it'. Let the watermelon be seasonal only, not nationalism. Amen.

Questions:
(a) What is the passage about? What is it that the author wants to convey?
(b) Why do you think the author finds his/her students attire interesting? Do they have anything to do with the "nationalistic enthusiasm"?
(c) "The tailors' are also boiling with 'nationalistic enthusiasm"' – comment on the tone of the author. Was it a tone of disbelief; or of frustration; or of ridiculation?
(d) Why do you think the author is calling the "semi-summer" comprising March as "The season of watermelon"?
(e) The last word of the passage is "Amen", which suggests that it is a kind of prayer; what is the prayer about?

6. (a) What are the elements of a Report and how are they organized? Discuss briefly.
(b) As the Purchase Officer of OTOBI, you had ordered 15 dozen bed sheets after examining the samples sent by the wholesaler. When this consignment arrives you find neither in texture nor in shades do the sheets conform to the samples you had approved. Write a claim letter demanding their replacement.
(c) Give phonetic spellings of the following words (Any Five):
yesterday, about, chair, boat, celebration, achievement
7. (a) What are the styles of presentation you can follow while writing business correspondence?

(b) Write a composition on any one of the following topics:

   (i) Facebook and Virtual Friendship
   (ii) My Favourite Film
   (iii) The Third World

(c) Write a dialogue between an employer and an employee. The employer wishes to fire/sack the employee who has been very irregular since last few months.

8. (a) Transform the following sentences as directed (Any Five):

   (i) Resist the devil and he will flee from you. (Simple)
   (ii) I know where he was born. (Simple)
   (iii) He had all the qualifications for the post except honesty. (Compound)
   (iv) One word more and I will turn you out. (Complex)
   (v) As soon as he gives a command, it is carried out. (Compound)
   (vi) He was sincere, and so he gained prominence. (Simple)

(b) "The main purpose of a sales letter is to convert the reader into a customer" – How is this purpose achieved?

(c) Write short notes on any three of the following:

   (i) The six steps of collection procedure.
   (ii) Difference between a tender and a quotation
   (iii) Semantic gap
   (iv) Consonants
L-2/T-1/EEE
Date: 31/12/2012
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USE SEPARATE SCRIPTS FOR EACH SECTION

SECTION – A

There are FOUR questions in this section. Answer any THREE questions including Q. No. 1 as compulsory.

1. (a) Explain with reference to the context any two of the following:

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(b) Attempt any one of the following:

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Contd ........... P/2
HUM 135
Contd ... Q. No. 2

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(i) The six steps of collection procedure.
(ii) Difference between a tender and a quotation
(iii) Semantic gap
(iv) Consonants

-------------------------------------------
SECTION - A

There are FOUR questions in this section. Answer any THREE.

1. (a) Illustrate the concept of production function. (5)
   (b) Narrate the various forms of productivity. (10)
   (c) State and prove the application of Euler’s theorem in the theory of distribution of production. (10)
   (d) Briefly discuss the various internal and external economics of scale of production. (10)

2. (a) Define optimization. How can it be achieved? Why is optimization necessary with reference to the production of a firm? (10)
   (b) Explain graphically the two conditions of equilibrium of a firm under perfectly competitive market. (10)
   (c) What is meant by the shut-down point of production of a firm? Explain graphically the shut-down point of production of a firm under perfect competition. (5)
   (d) Given the following total revenue (TR) and total cost (TC) functions for a firm (10)
       (i) Set up the profit function,
       (ii) Find the critical point(s) and
       (iii) Calculate the maximum profit.
       \[ TR = 1000Q - 2Q^2 \]
       \[ TC = Q^3 - 59Q^2 + 1315Q + 2000 \]

3. (a) Illustrate the concepts of national income, GNP, GDP and NNP. (5)
   (b) Describe the circular flow of income and expenditure in a two sector economy. (5)
   (c) Briefly discuss the various policies for controlling inflation with reference to the context of Bangladesh. (15)
   (d) Given that
       GNP = Tk. 1,03,000 crore
       Depreciation = Tk. 9,000 crore
       Indirect tax = Tk. 12,500 crore
       Subsidy is 20% of indirect tax
       Calculate national income. (10)
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4. (a) Explain the concept of “vicious circle of poverty”? How can this circle be broken? (15)
(b) What are the differences between economic growth and economic development? Explain the characteristics of least developed countries. (10)
(c) Explain the "Harrod-Domar" growth model of economic development. (10)

SECTION – B
There are FOUR questions in this section. Answer any THREE.

5. (a) Define demand function. (5)
(b) What are the factors that influence the shifting of a demand curve? (10)
(c) What are the exceptions to the law of demand? Explain them. (10)
(d) What is market demand? Derive the market demand for a commodity. (10)

6. (a) What are the properties of an indifference curve? Explain them. (15)
(b) Explain consumer's equilibrium with the help of budget line and indifference curve. (10)
(c) Show that total effect of a price change is equal to substitution effect and income effect. Present and explain all necessary diagrams. (10)

7. (a) Show that price elasticity of demand varies from zero to infinity along any straight line demand curve. (15)
(b) What are the determinants of price elasticity of demand? (10)
(c) From the following table calculate elasticity of demand if you move from point A to C and explain what you understand from the result. (10)

<table>
<thead>
<tr>
<th>Point</th>
<th>PX</th>
<th>QY</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>200</td>
<td>400</td>
</tr>
<tr>
<td>B</td>
<td>250</td>
<td>600</td>
</tr>
<tr>
<td>C</td>
<td>300</td>
<td>800</td>
</tr>
</tbody>
</table>

8. (a) How is price of a commodity is determined under competition? Explain graphically. (10)
(b) What will happen to the equilibrium price and quantity due to change in demand? (10)
(c) From the following demand and supply functions, calculate equilibrium price and quantity and show the result in a graph.

\[ P = 0.1Q + 8 \]
\[ P = -0.5Q + 50 \]

(i) If a per unit tax of Tk. 2 is imposed, how will it effect the equilibrium price and quantity? (15)
(ii) What will happen to the equilibrium price and quantity if government provides a subsidy of Tk. 3 per unit?
SECTION – A

There are FOUR questions in this Section. Answer any THREE.

1. (a) What are the analogues parameters in the magnetic circuit corresponding to V, I, R and G in the electric circuit? A flux of 4.8 mwb is produced when a current of 0.34 Amp is applied to a coil. Find the number of turns of the coil if the area of cross section of the core is 0.01 m.sq. and the average length of the flux path of the core is 0.45 m and \( \mu_r = 2500 \) and \( \mu_0 = 4\pi \times 10^{-7} \).

(17½)

(b) A ferromagnetic core with a relative permeability of 2000 is shown in the figure along with other dimensions. The depth of the core is 7 cm. Because of fringing effects the effective area of the air gaps is 5% larger than their physical size. What is the flux in each of the left, centre and right legs of the core if the current in the coil is 1.0 Amp.? (17½)

2. (a) What are the tests required to determine the parameters of the equivalent circuit of a transformer? Why the core loss is neglected in the short circuit test? What are the parameters obtained from this test? Write the expressions to determine these parameters. How much voltage is applied during this test? Will the parameters obtained from this test be referred to H.T or L.T side?

(17½)

(b) A 10 KVA, 2300/230 V, single phase transformer has the following resistance and reactance:

\[ R_p = 4.4 \ \Omega, \ R_s = 0.04 \ \Omega, \ R_C = 48 \ \Omega, \ X_M = 4.5 \ \Omega, \ X_P = 5.5 \ \Omega, \ X_S = 0.60 \ \Omega \]

The impedances of the excitation branch are given referred to H.T side of the transformer. Find

(i) The equivalent circuit referred to H.T side

(ii) The equivalent circuit referred to L.T side

(iii) The per unit equivalent circuit.

Contd ........ P/2
3. (a) What are the factors on which the voltage regulation of a transformer depends? Drawing appropriate vector diagrams show that the voltage regulation is higher in case of lagging load compared to that of leading load.

(b) A 10 KVA, 2300/230 volt transformer is supplying rated load at rated voltage and at a power factor of 0.8 lagging. Its equivalent resistance and reactance, referred to H.T side, are $R_{eq} = 8.4 \, \Omega$ and $X_{eq} = j\, 11.5 \, \Omega$. During the open circuit test, the wattmeter reading was 115 watt. Find;

(i) Input voltage
(ii) Voltage regulation and
(iii) Efficiency.

4. (a) What is all day efficiency? Why is it important in case of distribution transformers? Show that the maximum efficiency of a transformer can be achieved if the variable losses are equal to the fixed losses.

(b) A single phase, 12 KVA, 480/120 volt transformer is operating under maximum efficiency condition. The load is connected to L.T side of the transformer consuming 10 Amp. If the core loss is 38 watt, what is the equivalent resistance referred to L.T side?

SECTION – B

There are FOUR questions in this section. Answer any THREE.

5. (a) With neat sketches, explain how the rotating magnetic field is developed in the stator of a 3-phase, 2-pole induction motor. Also mathematically derive the expression of magnetic field and show that it is a rotating field.

(b) A three phase 230-V, 60-Hz, A50-hp, six pole induction motor operating at rated conditions has 91% efficiency and draws a line current of 124 A. The core loss, stator copper loss and rotor conductor loss are 848 W, 1400 W and 775 W, respectively. Draw the power flow diagram of the motor, and show numerical values of all the different losses, input power, air gap power and mechanically developed power in the diagram. Show detailed calculations.

(c) A three phase four pole motor is drawing 200 A line current at 208 V (line to line) at 0.8 pf (lagging). If the efficiency of the motor is 96%, calculate the shaft torque of the motor.

Contd .......... P/3
6. (a) The following test data were obtained from no-load, blocked-rotor, and DC test of a three-phase, wye-connected 40-hp, 60-Hz, 460-V, design B induction motor whose rated current is 57.8 A. Blocked rotor test was made at 15 Hz.

<table>
<thead>
<tr>
<th>Blocked Rotor</th>
<th>No Load</th>
<th>DC</th>
</tr>
</thead>
<tbody>
<tr>
<td>( V_{\text{line}} ) = 36.2 V</td>
<td>( V_{\text{line}} ) = 460.0 V</td>
<td>( V_{\text{DC}} ) = 12.0 V</td>
</tr>
<tr>
<td>( I_{\text{line}} ) = 58.0 A</td>
<td>( I_{\text{line}} ) = 30 A</td>
<td>( I_{\text{DC}} ) = 59.0 A</td>
</tr>
<tr>
<td>( P_{3\text{phase}} ) = 2570 W</td>
<td>( P_{3\text{phase}} ) = 4660 W</td>
<td></td>
</tr>
</tbody>
</table>

(For Design B, \( X_1 = 0.4 \times X_{BR} \), \( X_2 = 0.6 \times X_{BR} \))

(i) Draw the equivalent circuit of the motor referred to stator, showing numerical values of each circuit parameter. Show detailed calculation for determining the numerical values.

(ii) Find the combined Core and Friction and Windage loss.

(b) The rotor of a 25 hp six pole 50 Hz induction motor has equivalent resistance and equivalent reactance per phase of 0.1 \( \Omega \) and 0.54 \( \Omega \), respectively. If the slip of the motor is 0.02, then determine (i) rotor speed in rpm (ii) rotor impedance (iii) rotor current.

7. (a) A three phase 25 hp, 230 V, 60 Hz two pole induction motor drives a load that demands a constant torque regardless of the speed. (The load torque is independent of speed) The machine is operating at rated voltage, rated frequency and rated speed of 3575 rpm. Determine shaft horse power, speed and efficiency if the frequency drops to 54 Hz. The power factor and line current for the new condition are 89 percent and 55 A, respectively, and the respective stator conductor loss, rotor conductor loss and core loss are 992.7 W, 496 W and 546 W.

(b) Consider the 4 pole motor whose name plate is given in Figure for Question 7(b) (i). Find the minimum locked rotor torque, minimum breakdown torque starting torque and maximum expected starting current for the motor.
Contd Q. No. 7(b)

<table>
<thead>
<tr>
<th>Data for 1hp Motor</th>
<th>Design A &amp; B</th>
<th>Design C</th>
<th>Design D</th>
<th>Design E</th>
</tr>
</thead>
<tbody>
<tr>
<td>Minimum Locked Rotor Torque in percent of Full Load Torque</td>
<td>275%</td>
<td>285%</td>
<td>275%</td>
<td>190%</td>
</tr>
<tr>
<td>Minimum Breakdown Torque in percent of full load torque</td>
<td>300%</td>
<td>200%</td>
<td>--</td>
<td>--</td>
</tr>
</tbody>
</table>

Figure for Question 7(b) (ii).

NEMA code letters for locked-rotor kVA per horsepower

<table>
<thead>
<tr>
<th>Code Letter</th>
<th>kVA/hp&lt;sup&gt;b&lt;/sup&gt;</th>
<th>Code Letter</th>
<th>kVA/hp&lt;sup&gt;b&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>0.0–3.15</td>
<td>K</td>
<td>8.0–9.0</td>
</tr>
<tr>
<td>B</td>
<td>3.15–3.55</td>
<td>L</td>
<td>9.0–10.0</td>
</tr>
<tr>
<td>C</td>
<td>3.55–4.0</td>
<td>M</td>
<td>10.0–11.2</td>
</tr>
<tr>
<td>D</td>
<td>4.0–4.5</td>
<td>N</td>
<td>11.2–12.5</td>
</tr>
<tr>
<td>E</td>
<td>4.5–5.0</td>
<td>P</td>
<td>12.5–14.0</td>
</tr>
<tr>
<td>F</td>
<td>5.0–5.6</td>
<td>R</td>
<td>14.0–16.0</td>
</tr>
<tr>
<td>G</td>
<td>5.6–6.3</td>
<td>S</td>
<td>16.0–18.0</td>
</tr>
<tr>
<td>H</td>
<td>6.3–7.1</td>
<td>T</td>
<td>18.0–20.0</td>
</tr>
<tr>
<td>J</td>
<td>7.1–8.0</td>
<td>U</td>
<td>20.0–22.4</td>
</tr>
<tr>
<td></td>
<td></td>
<td>V</td>
<td>22.4 and up</td>
</tr>
</tbody>
</table>

Figure for Question 7(b) (iii).

8. (a) The main and auxiliary windings of a hypothetical 120-V, 60 Hz, split-phase motor have the following locked rotor parameters: \( R_{mw} = 2.00 \ \Omega \), \( X_{mw} = 3.50 \ \Omega \), \( R_{aw} = 9.15 \ \Omega \), \( X_{aw} = 8.40 \ \Omega \). The motor is connected to a 120 V 60 Hz system. It is given that \( k_{sp} = 1.0 \), lb-ft/A<sup>2</sup>. Determine (i) the locked rotor torque in lb- (ii) Capacitance required in series with the auxiliary winding in order to obtain a 90 phase displacement between the current in main winding and current in auxiliary winding. (iii) locked rotor torque after connecting the capacitor with capacitance value of (ii).

SECTION - A

There are FOUR questions in this section. Answer any THREE.

1. (a) Show that the diode small-signal incremental resistance is given by, \( r_d = \frac{nV_T}{I_D} \).

Where the symbols have their usual meanings.

(b) If \( R_S = 260 \Omega \), find \( v_o/v_I \) for \( I = 1 \) mA and \( I = 0.01 \) mA for the circuit shown in Fig. Q. 1(b).

![Fig. Q. 1(b)]

2. (a) Consider the Zener diode circuit shown in Fig. Q. 2(a). (i) Determine \( V_o \) with no load
(ii) Find the change in the output voltage if \( V_{PS} \) changes by \( \pm 1 \) V (iii) Find \( V_o \) if \( V_{PS} = 10 \) V and \( R_L = 2 \) k\( \Omega \). Given: \( V_Z = 5.6 \) V at \( I_Z = 0.1 \) mA and \( r_Z = 10 \) \( \Omega \).

![Fig. Q. 2(a)]

(b) Find the value of \( R \) and the junction area of each diode (assume all four diodes are identical) relative to a diode with 0.7 V drop at 1 mA current. Given: \( n = 1 \) and \( V_o = 3 \) V when \( I_L = 0 \) and \( V_o \) changes by 40 mV per 1 mA of load current.

![Fig. Q. 2(b)]

Contd .......... P/2
3. (a) A full-wave rectifier is to be designed to produce a peak output voltage of 12 V, deliver 120 mA to the load, and produce an output with a ripple \( (V_r) \) of not more than 5 percent. An input line voltage of 120 V (rms), 50 Hz is available. (20)

(b) Find the steady-state output of the circuit shown in Fig. Q. 3(b).

4. (a) For the dc circuit in Fig. Q. 4(a), assume the MOSFET parameters are \( V_{in} = 2 \text{ V} \), \( K'_{n} = 80 \mu A/V^2 \), and \( W/L = 4 \). Choose \( R_1 \) and \( R_2 \) such that the current in the bias resistors is approximately one-tenth of \( I_D \). Assume \( I_D = 0.5 \text{ mA} \). (20)

(b) Draw the VTC of a CMOS inverter. Find the minimum permitted logic–1, \( V_{IH} \). (15)

SECTION B

There are FOUR questions in this section. Answer any THREE. The symbols have their usual meanings.

5. (a) For the source follower circuit shown in Fig. 5(a) calculate the input resistance, output resistance, voltage gain, open circuit voltage gain and overall gain. Why it is called source follower? (15+2)

(b) Design the amplifier circuit shown in Fig. 5(b) if \( K'_{n1} = 1 \text{ mA/V}^2 \), \( K'_{n2} = 400 \mu A/V^2 \), \( V_{t1} = V_{t2} = 1.2 \text{ V} \), \( I_{D1} = 0.2 \text{ mA} \), \( I_{D2} = 0.5 \text{ mA} \), \( V_{DS1} = V_{DS2} = 6 \text{ V} \), \( R_m = 100 \text{ k\Omega} \) and \( R_d = 4 \text{ k\Omega} \). Neglect the channel length modulation effect and assume \( W/L = 1 \). (18)

Contd .......... P/3
6. (a) Draw the different biasing arrangement of a BJT amplifier circuit and state their advantages and disadvantages.

(b) Determine the small signal voltage gain and output resistance of the common-gate circuit shown in Fig. 6(b). When \( I_{\text{Bias}} = 0.2 \, \text{mA} \), \( V_m = |V_{\text{pp}}| = 0.8 \, \text{V} \), \( K'_n = K'_p = 0.4 \, \text{mA/V}^2 \), \( \lambda_n = \lambda_p = 0.01 \, \text{V}^{-1} \) and \( W/L = 1 \) for all the transistors.

7. (a) For the circuit shown in Fig. 7(a), determine the small signal parameters \( g_m, r_n \) and \( r_e \) for both the transistors, the overall small signal voltage gain \( A_v = \frac{V_o}{V_s} \), input resistance \( R_{\text{in}} \) and output resistance \( R_{\text{out}} \). Here \( \beta = 120 \).

(b) For the transistor circuit shown in Fig. 7(b), \( \beta = 30 \). Determine \( V_i \) such that \( V_{CE} = 6 \, \text{V} \).

8. (a) For the circuit shown in Fig. 8(a), the transistor parameters are \( R_1 = 10 \, \text{k}\Omega \), \( \beta = 50 \) and \( V_{BE_1} = V_{BE_2} = 0.7 \, \text{V} \). Determine \( I_{B1}, I_{B2}, I_{C1} \) and \( I_{C2} \). Assume that all the transistors are identical.

(b) Consider the common base circuit in Fig. 8(b), the transistor parameters are \( \beta = 120 \) and \( V_A = \infty \). Determine the bias point (Q point) and small signal voltage gain \( v_o/v_s \).

(c) For the circuit shown in Fig. 8(c), find the value of the base voltage so that the transistor operates in saturation with a forced \( \beta \) of 5.
Fig. 5(a)

Fig. 5(b)

Fig. 6(b)

Fig. 7(a)

Fig. 7(b)
Fig for 6.8(a)  Fig for 6.8(b)  Fig for 6.8(c)
1. (a) Prove that every square matrix can be expressed in one and only one way as the sum of a symmetric matrix and a skew symmetric matrix.

(b) Solve the following system of linear equations:

\[
\begin{align*}
    x_1 + 2x_2 - 3x_3 + x_4 &= 4 \\
    -2x_1 + x_2 + 2x_3 + x_4 &= -1 \\
    -x_1 + 3x_2 - x_3 + 2x_4 &= 3 \\
    4x_1 - 7x_2 - 5x_4 &= -5 \\
\end{align*}
\]

(c) Solve the following equation:

\[
\begin{bmatrix}
1 + x & x & 3 + x \\
x & 1 + x & 2 + x \\
\end{bmatrix} = 0.
\]

2. (a) Compute the inverse of \( A = \begin{bmatrix} 1 & 2 & -2 & -1 \\ -1 & -4 & 4 & 0 \\ 2 & -7 & 4 & -7 \\ 1 & 6 & -5 & 1 \end{bmatrix} \). Also express \( A \) as a product of elementary matrices.

(b) Find the canonical matrix row equivalent to the following matrix:

\[
\begin{bmatrix}
1 & 2 & 3 & 4 \\
2 & 7 & 3 & 5 \\
3 & 8 & 1 & -2 \\
2 & 4 & 6 & 8 \\
\end{bmatrix}
\]

Also find the rank of the matrix.

3. (a) Reduce \( A = \begin{bmatrix} 1 & 2 & 3 & 4 \\ 2 & 3 & 4 & 6 \\ 3 & 4 & 5 & 7 \\ 4 & 5 & 5 & 7 \end{bmatrix} \) to the normal form \( B \) and compute the matrices \( P \) and \( Q \) such that \( PAQ = B \).
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Contd ... Q. No. 3(a)

(b) Given, \( A = \begin{bmatrix} 19 & -9 & -6 \\ 25 & -11 & -9 \\ 17 & -9 & -4 \end{bmatrix} \). Determine whether \( A \) is diagonalizable. If so, find a matrix \( P \) that diagonalizes \( A \), and determine \( P^{-1} AP \).

4. (a) State Cayley-Hamilton theorem. Verify Cayley-Hamilton theorem for the matrix

\[
A = \begin{bmatrix}
1 & -1 & 1 \\
1 & 2 & 1 \\
1 & 0 & 3
\end{bmatrix}
\]

and hence find \( A^{-1} \).

(b) Reduce the following quadratic form \( q \) to the canonical form and find the rank, index and signature of \( q \). Also write down the corresponding equations of transformations.

\[
q = 4x_1^2 + 3x_2^2 - x_3^2 + 2x_2x_3 - 4x_3x_1 + 4x_1x_2.
\]

**SECTION - B**

There are FOUR questions in this Section. Answer any THREE.

5. (a) Find the standard matrix for the transformation \( T \) on \( \mathbb{R}^3 \), where \( T \) is the composition of a rotation of \( 45^\circ \) about \( y \)-axis, followed by a reflection about \( yz \)-plane, followed by a dilation with factor \( k = \sqrt{2} \). Then find \( T(2, -5, 8) \) using the standard matrix.

(b) Consider the set \( P_2 \) of all polynomials of degree 2 and the set \( S = \{ p_1, p_2, p_3 \} \) where, \( p_1 = 1 + x \), \( p_2 = 1 + x^2 \), \( p_3 = x + x^2 \). Is the set \( S \) a basis for \( P_2 \)? If so, then find the coordinate vector of the polynomial \( p(x) = 2 - x + x^2 \) relative to the basis \( S \).

6. (a) (i) Find a subset of vectors \( v_1 = (1, -2, 0, 3), v_2 = (2, -5, -3, 6), v_3 = (-4, 11, 9, -12), v_4 = (2, -1, 4, -7) \) and \( v_5 = (5, -3, 11, -11) \) that forms a basis for the space spanned by these vectors. (ii) Express each vector not in the basis as a linear combination of the basis vectors.

(b) Find the Kernel and Range of (i) orthogonal projection on \( xz \)-plane; (ii) orthogonal projection on the plane defined by \( x = z \). Write down a basis and the dimension of Kernel and Range in each case.
7. (a) Consider the set of all $2 \times 2$ matrices of the form \[
\begin{bmatrix}
a & 1 \\
1 & b
\end{bmatrix},
\] where $a$, $b$ are real numbers.

Is the above set with standard matrix addition and scalar multiplication a vector space? If not then show all the axioms of vector space that fail to hold.

(b) Determine whether the following subsets are subspaces of $\mathbb{R}^4$. If so, then find a basis in each case and their dimensions.

(i) all vectors of the form $(a, b, c, d)$, where $d = 2a + 7c$ and $3c = 2a - 5b$.

(ii) all vectors of the form $(a, b, 0, c)$, where $5a = 3c$.

8. (a) Let $T: P_2 \to P_3$ be the linear transformation defined by $T(p(x)) = x \cdot p(x - 3)$, that is $T(a + bx + cx^2) = x(a + b(x - 3) + c(x - 3)^2)$. Find the matrix for $T$ with respect to the standard bases $B = \{1, x, x^2\}$ and $B' = \{1, x, x^3\}$. If $X = p(x)$ is any element in $P_2$, then verify that $[T]_{B'}_{B}[X]_{B} = [T(X)]_{B'}$.

(b) Consider the vector space $\mathbb{R}^3$ with the Euclidean inner product. Apply Gram-Schmidt process to transform the basis vectors, $u_1 = (1, 1, 1)$, $u_2 = (-1, 1, 0)$, and $u_3 = (1, 2, 1)$ into an orthogonal basis $\{v_1, v_2, v_3\}$; then normalize the orthogonal basis vectors to obtain the orthonormal basis $\{q_1, q_2, q_3\}$. 

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