B.Tech. / B.Des. (V Sem.)

604 **Paper 5.1**

B.Tech. / B.Des. (FIFTH SEMESTER) EXAMINATION, DECEMBER 2016

PAPER 5.1— **Women in Indian Society**

TIME ALLOWED : TWO HOURS

Maximum Marks— 30

*Attempt any **four** questions.*
All questions carry equal marks.

*किन्हीं **चार** प्रश्नों के उत्तर दीजिये।*
सभी प्रश्नों के अंक समान हैं।

1. Define the concepts of sex and gender. Describe the characteristics of sex.

   लिंग और जेंडर की अवधारणाओं को परिभाषित कीजिये। लिंग (sex) की विशेषताओं का वर्णन कीजिये।

2. Explain the implications of constitutional provisions with reference to discriminatory practices.

   भेदभावपूर्ण व्यवहार के संदर्भ में संवैधानिक प्रावधानों के निहितार्थों की व्याख्या कीजिये।

3. Describe women's participation in Indian Freedom Movement.

भारतीय स्वतंत्रता आंदोलनों में महिलाओं की सहभागिता (भागीदारी) का वर्णन कीजिये ।

4. Explain social, educational, political and economic status.

सामाजिक, शैक्षिक, राजनीतिक और आर्थिक स्थितियों की व्याख्या कीजिये ।

5. Describe property rights of women among Hindus and Muslims.

हिन्दुओं और मुसलमानों की महिलाओं के सम्पत्ति के अधिकारों का वर्णन कीजिये ।

6. Discuss sexual harassment at workplace.

कार्यस्थल पर यौन उत्पीड़न की विवेचना कीजिये ।

7. Write an essay on "Women's Movements in India".

"भारत में महिलाओं के आन्दोलन" पर एक निबन्ध लिखिये ।

B.Tech./B.Pharma.(V Sem.)/LL.B. (VII Sem.)

605 **PHFR**

B.Tech. / B.Pharma. (FIFTH SEMESTER) / LL.B. (SEVENTH SEMESTER) EXAMINATION, DECEMBER 2016

PAPER F 5.1— PARENTHOOD AND FAMILY RELATIONS

TIME ALLOWED : TWO HOURS

Maximum Marks— 30

The paper containts seven questions in all.
*Candidates are required to attempt any **four**.*

प्रश्नपत्र में कुल सात प्रश्न हैं।
*परीक्षार्थी को कोई **चार** प्रश्न करने हैं।*

1. Explain the different functions of female reproductive system and draw a beautiful diagramme.

   स्त्री प्रजनन तन्त्र की विभिन्न कार्यप्रणाली को समझाइये व इसका एक सुन्दर चित्र भी बनाइये। 7 1/2

2. Describe various common ailments and their preventive measures in children.

Turn over

बालकों में होने वाले साधारण रोगों व उनके रोकथाम के तरीकों का वर्णन कीजिये। 7 1/2

3. Write short notes on:—

(i) Complications during pregnancy

(ii) Physical development of child.

निम्न पर टिप्पणी लिखिये:—

(i) गर्भावस्था के दौरान होने वाले कष्ट

(ii) बालक का शारीरिक विकास। 3 3/4 × 2 = 7 1/2

4. Explain the various child rearing techniques and its impact on child's personality.

बालक की देखभाल की विभिन्न विधियों व बालक के व्यक्तित्व पर इसके प्रभाव का वर्णन कीजिये। 7 1/2

5. What do you mean by family planning? Why is it important for us? Explain in detail its various methods.

परिवार नियोजन से क्या अभिप्राय है? यह हमारे लिये किस प्रकार उपयोगी है? इसके विभिन्न प्रकारों का विस्तारपूर्वक वर्णन कीजिये। 7 1/2

6. Discuss the various STDs and sexual misbehaviour. How is sex education helpful to overcome it?

विभिन्न एस०टी०डी० व लैंगिक दुर्व्यवहार पर चर्चा कीजिये। इसको कम करने में यौन शिक्षा किस प्रकार उपयोगी है? 7 1/2

7. Write short notes on:—

(i) Drug addiction

(ii) Mental health and hygiene.

निम्न पर टिप्पणी लिखिये:—

(i) ड्रग एडिक्शन

(ii) मानसिक स्वास्थ्य व स्वच्छता। 3 3/4 × 2 = 7 1/2

B.Tech. (CE / BT / EI) (V Sem.)
606 **Paper 5.1**

B.Tech. (CE / BT /EI) (FIFTH SEMESTER) EXAMINATION, 2016

PAPER 5.1 - Economics for Engineers

Time Allowed : 3 HOURS

Maximum Marks : 30

This question paper is divided into three Sections. Students are required to attempt FIVE questions in all, selecting not more than TWO questions from each Section. All questions carry equal marks.

SECTION-A

1. What is Law of Demand? Explain the factors which determine the market demand for a commodity.
2. Explain any three of the following: -
   a) Difference between micro and macro economics.
   b) Origin and meaning of Engineering economics
   c) Types of demand
   d) Demand curve
3. What are different types of Elasticity of demand? Explain any one method of its measurement with suitable example.

SECTION-B

4. Explain the Law of variable proportions. In which state a rational producer will choose to produce?
5. What are different types of market structures? Discuss

the various features of perfect competition.

6. Explain the following: -

   a) Concept of cost

   b) Production function

   c) Equilibrium price

SECTION-C

7. A loan of Rs. 2000 is made today under the agreement that 2500 will he receive after some time. Find out "N", if the rate of interest is 8% compounded semi annually.

8. Define depreciation. What are the different causes of depreciation?

9. Explain any three of the following:

   a) Concept of Capital budgeting

   b) Cash flow diagram

   c) Internal rate of return

   d) Straight line method for calculating depreciation

B.Tech. (CS/IT/EC/EE) (V Sem.)

607 **Paper 5.1**

B.Tech. (FIFTH SEMESTER) EXAMINATION, DECEMBER 2016

(CS/IT/EC/EE)

PAPER 5.1— **Principles of Management**

TIME ALLOWED : THREE HOURS

Maximum Marks— 30

This question paper is divided into three Sections. Students are required to attempt five questions in all, taking not more than two questions from each Section.

All questions carry equal marks.

SECTION A

1. "Indian economy is not underdeveloped but under-managed." Discuss and explain how efficient management can make the country and its inhabitants prosperous.

2. Why is decision making often described as the essence of a manager's job? Also discuss the process of decision making.

3. Discuss the general framework for planning. How are strategic planning, tactical planning and operational planning different?

SECTION B

4. When a project structure is superimposed on a functional structure, the result is a matrix. It is also referred to as a "multiple command system". Explain. Discuss the important features, strengths and weaknesses of grid organization.

5. "Decentralization leads to managerial creativity, ingenuity, entrepreneurial spirit and growth of professional managers. It improves enthusiasm and organisation's human resources." Explain and elaborate.

6. How could you use expectancy theory to increase your own motivational level?

SECTION C

7. "In reaction to new situations, modern leadership styles concentrate on getting employees involved in the organisation and giving them the freedom to use their abilities as they think best." Elucidate and discuss charismatic leadership and transformational leadership approaches.

8. Emplyees continue to emphasize good communication skills as one of the most important qualifications for

screening career school and business graduates. What are some of the reasons for this requirement?

9. "In control, standards must be attainable, and the methods used to evaluate performance should foster harmony, not cynicism." Explain what are the other requirements for effective control.

(b) There are 50 people in a room. Some of them are acquainted with each other and some not. Prove that there are two persons in the room who have equal number of acquaintances.

8. (a) Let there are three pegs mounted on a board together with n disks of different sizes. Initially these disks are placed on the first peg in order of size, with the largest on the bottom. Find the number of moves required to have all the disks on the second peg in order of size, with the largest on the bottom, if there is a condition that disks are to be moved one at a time from one peg to another and a disk is never placed on top of a smaller disk. Also there is a third peg on which disks can be placed temporarily. Also find the number of moves if there are 5 disks. 4

(b) Write a note on asymptotic behaviour of numeric functions. 2

(c) Find the generating function of the sequence $a, a, 0, a, a, 0, a, a, 0, \ldots\ldots$. 2

9. (a) Solve the recurrence relation

$$a_n + 5a_{n-1} + 6a_{n-2} = 3n^2 - 2n + 1$$ 3

(b) Solve using generating function:–

$$\sum_{k=0}^{r} {}^{m}C_k \; {}^{n}C_{r-k} = {}^{m+n}C_r$$ 3

(c) Find numeric function for generating function:–

$$A(z) = \frac{1}{3 - z^3}$$ 2

B.Tech. (CS) (V Sem.)

608 Paper 5.2

B.Tech. (COMPUTER SCIENCE AND ENGINEERING) (FIFTH SEMESTER) EXAMINATION, DECEMBER 2016

PAPER 5.2— **Discrete Mathematics**

TIME ALLOWED : THREE HOURS

Maximum Marks— 40

*The question paper is divided into three Sections. Students are required to attempt **five** questions in all, selecting not more than **two** questions from each Section.*

SECTION A

1. (a) Prove that the number of permutations of n-objects, taken r at a time, allowing repetition, is n^r. 3

(b) In how many ways can 8 persons be seated at a round table so that all shall not have the same neighbours in any two arrangements? 3

(c) How many ternary strings of length two are possible? 2

2. (a) Let $X = \{1, 3, 5, 7, 15, 21, 35, 105\}$ and R be the relation '/' (divides) on the set X. If $(X, /)$ is a POSET:–

(i) Draw the Hapse diagram of the POSET

(ii) Determine LUB of 3 and 7

(iii) Determine GLB of 15 and 35

(iv) Determine greatest and least elements of X. 4

(b) What do you understand by bijection mapping? If a real valued function is defined as $f(x) = ax + b$, where $a, b, x \in R$ and $A \neq 0$, show that the function is one-one and on-to. Also find the inverse function of the given function, if it exists. 4

3. (a) Let $E(x_1, x_2, x_3) = (x_1 \vee x_2) \wedge (x_1 \vee x_3) \wedge (x_2 \vee \bar{x}_3)$ be a Boolean expression over the two valued Boolean Algebra. Write $E(x_1, x_2, x_3)$ both in disjunctive normal form (DNF) and conjunctive normal form (CNF). 4

(b) Let $(A, \vee, \wedge, -)$ be a finite Boolean Algebra. Let b be any non-zero element in A, and $a_1, a_2, \ldots, a_K$ be all the atoms of A such that $a_i \leq b$. Then $b = a_1 V a_2 V \ldots V a_K$ is the unique way to represent b as a join of atoms. Prove it. 4

Section B

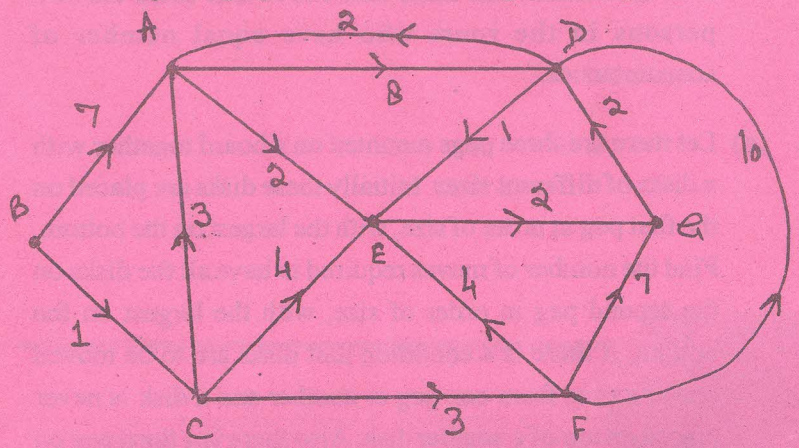
4. (a) Prove or disprove following statements:–

(i) The number of vertices of odd degree in a graph G is always even.

(ii) A simple graph can not have the degrees of all its vertices distinct. 2+2

(b) Show that in a complete graph with n-vertices there are $\left(\frac{n-1}{2}\right)$ edge-disjoint Hamiltonian circuits, if n is an odd number ≥ 3. 4

5. (a) What is the shortest path between B and G, in the following weighted graph. Also find the length of the path. 4



(b) Prove that a connected graph G is an Euler graph if and only if it can be decomposed in to circuits. 4

6. (a) Define following with appropriate examples:

(i) Multi-graph (ii) Cut sets

(iii) Wheel (iv) Hamiltonian circuits 2

(b) Show that a tree with n vertices has $n - 1$ edges. 2

(c) Show that the number of vertices in a binary tree is always odd. 2

Section C

7. (a) In a town 45% read magazine A, 55% read magazine B, 40% read magazine C, 30% read magazines A and B, 15% read magazines B and C, 25% read C and A, 10% read all the three magazines. Find:–

(i) What percentage do not read any magazine

(ii) What percentage reads exactly two of the magazines. 4

MOV C, 00_4

XCHD A, @ R1

PUSH 00_4 4

(b) Explain the timer modes. What is the use of mode-2? 4

B.Tech. (CSE/EC/IT/EI) (FIFTH SEMESTER) EXAMINATION, DECEMBER 2016

(CSE/EC/IT/EI)

PAPER 5.3— **Microprocessors and Microcontrollers**

TIME ALLOWED : THREE HOURS

Maximum Marks— 40

This question paper is divided into three Sections.

*Students are required to attempt **five** questions in all, selecting not more than **two** questions from each Section.*

All questions carry equal marks.

SECTION A

1. (a) With the help of a neat diagram, explain the architecture of 8086 microprocessor alongwith function of each block and register. 4

(b) What is the difference between 8085 and 8086 micro processor architecture and instruction set? 4

2. (a) Identify the addressing modes used in each of the following 8086 instructions:–

(i) MOV BX, 03544

(ii) ADD AL, 04[BX]

(iii) MOV AX, [BX] [SI]

(iv) MOV AX, [BX + SI + 04] 4

(b) Write a program to generate fibonacci series for 8086 microprocessor. 4

3. (a) What are the flap control instructions used in 8086 microprocessor? 4

(b) What are the benefits of pipelined architecture and advantages of segmentation? 4

Section B

4. (a) Draw an interfacing diagram to interface an 8 bit analog to digital converter from 8255 to 8086 in I/O mapped I/O. Write a program to take the samples of input analog signal at one interval of 2s, convert it into digital and save it at memory location 90004. 4

(b) Draw and explain the block diagram of 8259A. 4

5. (a) Explain the interfacing of 8254 with 8086 with the help of a neat diagram. 4

(b) Explain input and output modes of operation of 8279 in detail. 4

6. (a) Explain architecture of 8251 USART with the help of a neat diagram. 4

(b) Explain the working of a DMA controller. What are its applications? 4

Section C

7. (a) Explain the internal RAM organisation of 8051. Discuss how switching betweeen register banks is possible. Give a sequence of instructions to switch from bank-0 to bank-2. 4

(b) List different modes of data communication available in 8051 microcontroller and explain any one in detail. 4

8. (a) With a neat sketch, discuss the internal architecture of 8051. 4

(b) Write a program to subtract a 16-bit data of register R0 – R1 from another 16-bit data stored in R2 – R3. Save the result in memory locations 404 and 414. 4

9. (a) Explain the following instructions:–

MOV $7F_4$, C

ORL C,/$7D_4$

B.Tech. (FIFTH SEMESTER) EXAMINATION, DECEMBER 2016

(CS/IT)

PAPER 5.4— **Java Programming**

TIME ALLOWED : THREE HOURS

Maximum Marks— 40

The question paper is divided into three Sections. Students are required to attempt five questions in all, selecting not more than two questions from each Section.

All questions carry equal marks.

Section A

1 (a) Differentiate between constructor and method of class. Define method overloading and its purpose. Write a program to demonstrate the constructor overloading.

(b) Write a program to create directories (/home/abc/bcd/def/ghi/jkl) in the home directory /home/abc and list the files and directories showing file/directory, file size. Read-write-execute permissions. Write destructor to destroy the data of a class.

2 (a) What do you mean by access specifier and why they are used? How they affect the life and scope of variables in any program. Explain with example

(b) Write a program that illustrates interface inheritance. Interface P is extended by P1 and P2. Interface P12 inherits from both P1 and P2.Each interface declares one constant and one method. class Q implements P12. Instantiate Q and invoke each of its methods. Each method displays one of the constants.

3 (a) Discuss basic in-built packages in java and their uses in application development in brief. Which Package is the default package? Explain.

(b) The abstract vegetable class has three subclasses named Potato, Brinjal and Tomato. Write a java program that demonstrates how to establish this class hierarchy. Declare one instance variable of type String that indicates the color of a vegetable. Create and display instances of these objects. Override the toString() method of object to return a string with the name of vegetable and its color.

SECTION B

4 (a) What is Exception? Explain various Built-in exceptions in java. Also give difference between throw and throws keywords.

(b) Write in brief about following

(i) JDBC-ODBC bridge

(ii) Resultmetadata

(iii) Connection

(iv) Classforname()

5 (a) Explain in detail different types of stream based I/O in Java ?

(b) Write an application that searches through its command-line argument. If an argument is found that does not begin with and upper case letter, display error message and terminate.

6 (a) What are the difference between a server socket and a client socket? How does the following happens ?

(i) Client initiate a connection

(ii) Server accept a connection

(iii) Data is transferred between a client and a server

(b) It is required to have total two threads, both capable of acting as a produce as well as a consumer. If first thread acts as a producer then, the second thread becomes the consumer and vice-versa. They communicate with each other through a buffer, storing one integer number. One of the threads initiates the communication by sending 1 to the other thread. The second thread, on receiving 1 sends 2 to the first thread. On receiving 2, the first thread sends three integer numbers, one by one to the second thread. The second thread consumes the numbers by displaying them. Both threads terminate after that. Note that both threads must be capable of initiating the communication.

Write complete multi-threaded program to meet above requirements.

SECTION C

7 (a) What are the major components of Java's event delegation model ? Explain the working of event delegation model by giving suitable example.

(b) Write a program to create a frame with exit capabilities. Handle events for mouse pressed, mouse released, mouse clicked and mouse dragged by displaying appropriate message describing the event at the coordinates where the event has taken place.

8 (a) What do you understand by AWT controls ? Explain the various controls supported by AWT?.

(b) Write a complete program to create a frame for providing GUI to implement a stack for storing integer numbers. There are two buttons called PUSH & POP and a text field. Clicking of button PUSH pushes the number entered in the text field onto the stack. The click of button POP pops an element from the stack and displays that in the text field.

9 Write a short notes on the following :

(i) Servlet

(ii) JSP

(iii) Adapter Classes

(iv) Layout Managers

400

(ii) .EXC

(iii) .BAT

(iv) .OBJ 5

(b) Distinguish between character devices and block devices. 3

9. Write notes on the following:—

(a) ROM-BIOS

(b) Terminal Emulators

(c) Device Drivers

(d) Hardware Interrupts. 2×4=8

B.Tech. (CS / IT) (V Sem.)

611 Paper 5.5

B.Tech. (FIFTH SEMESTER) EXAMINATION, DECEMBER 2016

(CS / IT)

PAPER 5.5— **Systems Programming**

TIME ALLOWED : THREE HOURS

Maximum Marks— 40

Attempt five questions in all, taking not more than two questions from each Section.

All questions carry equal marks.

SECTION A

1. (a) What are system programs? How are they different from application softwares? Name any *four* system and application softwares each along with their use. 3

(b) What do you mean by addressing mode? Describe different types of addressing modes used by IBM 360 machine. 5

2. (a) Briefly discuss the function of each of the following:—

(i) PC

(ii) MAR

(iii) MBR

(iv) IR 6

(b) What feature of assembly language required us to build a two-pass assembler? 2

3. (a) Differentiate CR instruction and the CLR instruction. 2

(b) Which instruction will be executed after the BE SAME, why?

```
        CLI     =F'3', 3
        BE      SAME
        LR      3, 5
SAME    AR      5, 5
```

4

(c) Why must the operand field of the EQU pseudo-op be evaluated in pass1? 2

Section B

4. (a) List *two* advantages and disadvantages of:—

(i) Binding at load time over binding at assembly time.

(ii) Binding at execution time over binding at load time. 6

(b) Discuss the advantages and disadvantages of relocation process. 2

5. (a) Distinguish between multiprogramming and multiprocessing. What were the key motivations for the development of each? 4

(b) Explain operating system objectives and functions. 4

6. (a) Describe the directory structure of the UNIX file system. 2

(b) What are pipes and filters? What is a pipeline? 2

(c) Discuss stream editors and structure editors with their examples and the services provided by them. 2

(d) What are automated test drivers? Give any *six* different names for testing tools. 2

Section C

7. (a) What is the role of AUTOEXEC.BAT file? Give two examples of operations that the user might designate to be performed via this mechanism. 4

(b) Describe the structure of MS-DOS. 4

8. (a) Discuss the use of file extensions in MS-DOS. What do each of the following file extensions designate?

(i) .COM

(b) What are the physical and electronic security considerations in supporting the IT requirements of an organization? What are the various tools and measures that can be implemented to secure da ta? 4+4

B.Tech. (CS/IT) (V Sem.)

612 Paper 5.6

B.Tech. (CS/IT) (FIFTH SEMESTER) EXAMINATION, DECEMBER 2016

(C.S./IT)

PAPER 5.6— **Data Communication and Networks**

TIME ALLOWED : THREE HOURS

Maximum Marks— 40

This question paper is divided into three Sections. Students are required to attempt five questions in all, taking not more than two questions from each Section.

All questions carry equal marks.

SECTION A

1. (a) Define Computer Networks and list its applications. Discuss various topologies with merits and demerits for each.

(b) Differentiate between:—

(i) Microwave and Radio wave

(ii) Wireline and Wireless media. 4+4

2. (a) Define Data, Signal and Transmission. Discuss various techniques for converting analog data into digital signals, with merits and demerits for each.

(b) What is the significance of multiplexing? Compare and contrast its various types. 4+4

3. (a) What are the functions of a DTE? What are the functions of a DCE? Discuss functioning of one standard DTE-DCE interface.

(b) Compare and contrast various guided media on factors: data rates, BER, EMI/RFI, cost, frequency range and applications. 4+4

Section B

4. (a) What is TCP/IP model? Explain functions and protocols and services for each layer. Compare it with OSI model.

(b) What is the Internet? How is it related to ARPANET? Also discuss about Intranet and Extranet. 4+4

5. (a) What is IP Addressing? How is it classified? How is subnet addressing performed?

(b) What is IPv6? Explain its advantages over IPv4. Also discuss its frame format. 4+4

6. (a) What is an ethernet? Expalin ethernet frame. List some advantages and disadvantages of ethernet.

(b) Explain CSMA/CD protocol in detail. How does it detect collision? 4+4=8

Section C

7. (a) Define routing and discuss key factors for distance vector routing and link state routing.

(b) What is the purpose of DNS? Discuss the architecture of the domain name space. 4+4

8. (a) What is meant by Congestion? Why does congestion occur in network? Discuss different congestion controlling techniques.

(b) What is the function of SMTP? Discuss its architecture and the role of UA and MTA. How does MIME enhance SMTP? 4+4

9. (a) How is a secret key encryption different from public key encryption? Discuss advantages and disadvantages of each. What is a digital signature?

B.Tech. (IT) (V Sem.)

613 Paper 5.2

B.Tech. (IT) (FIFTH SEMESTER) EXAMINATION, DECEMBER 2016

BT

PAPER 5.2— **Information Systems and Security**

TIME ALLOWED : THREE HOURS

Maximum Marks— 40

This question paper is divided into three Sections. Students are required to attempt five questions in all, selecting not more than two questions from each Section. All questions carry equal marks.

SECTION A

1. (a) Explain Euclidean algorithm and apply it to find GCD of 2740 and 1760.

   (b) Would message integrity on its own ensure that the contents of a message are not changed during transit? Does something more need to be done? 4+4

2. (a) Discuss the strength of DES against brute force attacks. What is the need of triple DES?

(b) Discuss different security services in brief. 4+4

3. (a) Compare stream ciphers and block ciphers in terms of efficiency and modes of operation.

(b) Explain linear and differential cryptanalysis. 4+4

Section B

4. (a) Discuss different attacks possible on RSA.

(b) Explain the Miller-Rabin primality test. 4+4

5. (a) Discuss the properties of a good Hash algorithm.

(b) Explain the working of SHA-512 in brief. 4+4

6. (a) Explain Meet-in-the-middle attack scenario in Deffie Hellman key exchange algorithm.

(b) Discuss DSS in brief. 4+4

Section C

7. (a) Write short notes on the following:—

(i) PGP (Pretty Good Privacy)

(ii) Message Authentication. 2+2

(b) What are the issues in E-mail security? 4

8. (a) Why do we use SSL? How is a connection established between client and server using SSL?

(b) Explain IPSec with its different protocols and mode of operations used. 4+4

9. (a) Define Kerberos4 with the exchange of messages which takes place between its various servers.

(b) Explain Intrusion Detection System. Briefly discuss different intrusion detection techniques. 4+4

B.Tech. (EC/EI/EE) (V Sem.)

614 **Paper 5.2/5.3**

B.Tech. (EC/EI/EE) (FIFTH SEMESTER) EXAMINATION, DECEMBER 2016

PAPER : 5.2/5.3— **Analog Integrated Circuits**

TIME ALLOWED : THREE HOURS

Maximum Marks— 40

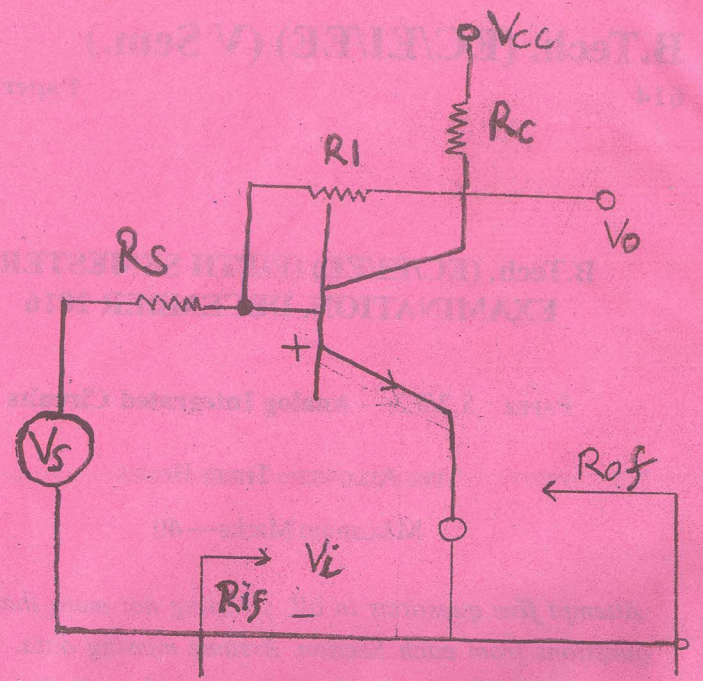
*Attempt **five** questions in all, selecting not more than **two** questions from each Section. Assume missing data, if any, suitably. Illustrate your answers with neat sketches wherever necessary. All questions carry equal marks.*

SECTION A

1. (a) Explain how negative feedback reduces effect of noise in amplifier. Compare signal to noise ratio (SNR) of an amplifier with and without negative feedback. 4

   (b) An amplifier has a voltage gain of 1000, f_L = 50 Hz, f_H = 200 kHz and a distortion of 5% without feedback. Find voltage gain, f_L, f_H and distortion when a negative feedback is applied with a feedback ratio of 0·01. 4

2. (a) The circuit shown in figure below has the following parameters; R_c = 4 kΩ, R' = 40 kΩ, R_s = 10 kΩ, h_{ie} = 1·1 kΩ, h_{fe} = 50 and h_{oe} = 0. Find R_{of}, A_{vf} and R_{if} 4



(b) Explain the effect of negative feedback on input resistance of current shunt feedback circuit. 2

(c) Find the expression for the output resistance of class AB power amplifier. 2

3. (a) Why can voltage amplifier be used as a power amplifier? 2

(b) Find an expression for second harmonic distortion factor of a BJT power amplifier in terms of I_{cmax} (maximum instantaneous collector current), I_{cmin} (minimum instantaneous collector current) and I_{CQ} (quiescent current) for an amplifier driven by a base current $I_b = I_{bm} \cos \omega t$. 4

(c) Show that efficiency of class-B power amplifier under the condition of maximum power dissipation is equal to 50%. 2

Section B

4. (a) The following low frequency parameters are known for a given transistor at $I_c = 10$ mA, $V_{CE} = 10$ V, and at room temperature $h_{ie} = 500\ \Omega$, $h_{oe} = 4 \times 10^{-5}$ A/V, $h_{fe} = 100$ and $h_{re} = 10^{-4}$, compute the value of g_m, $r_{b'e}$, $r_{bb'}$ and $r_{b'c}$. 4

(b) Derive an expression for the voltage gain of single stage common emitter transistor amplifier driven by a voltage source. (Do not use Miller approximation.) 4

5. (a) Show that the expression for gain-bandwidth product of voltage gain is given by:–

$$|A_{vso}\ f_H| = \frac{g_m R_L}{2\pi c (R_s + r_{bb'})} = \frac{f_A}{1 + 2\pi f_A C_C R_L} \frac{R_L}{R_s + r_{bb'}}$$

Plot the graph showing the variation of $|A_{vso} f_H|$ with R_L for different values of R_s. 4

(b) Why is step response performed in amplifier? Sketch the step response of a low-pass circuit and define rise time. For an amplifier, with 1 MHz upper cut-off frequency, determine rise time. 4

6. (a) The transfer function of an amplifier has n poles and k zeros; if the zeros are of much higher frequencies than poles, show that an approximate expression for high 3-dB frequency f_H^* is given by:–

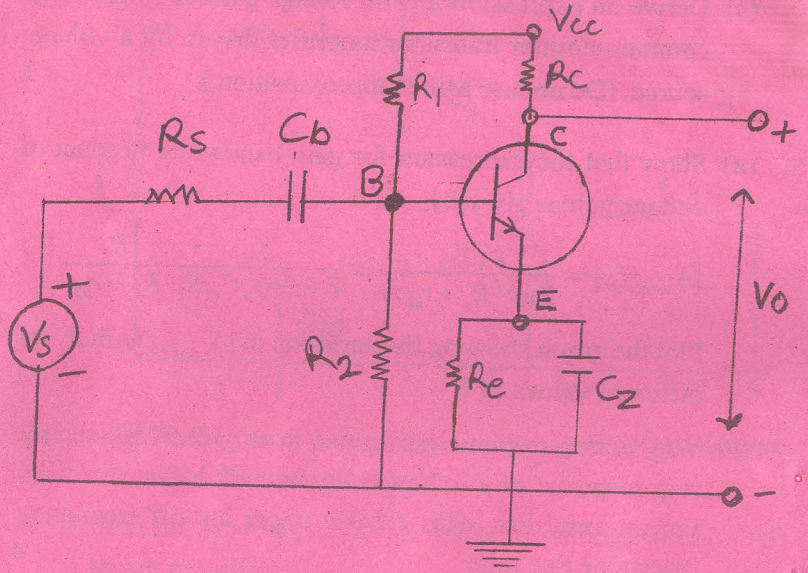
$$\frac{1}{f_H^*} = \sqrt{\frac{1}{f_1^2} + \frac{1}{f_2^2} + \ldots\ldots\ldots + \frac{1}{f_n^2}}$$ 4

(b) Consider single stage R-C coupled amplifier circuit shown in figure below with $R_1 = R_2 = 10$ kΩ, $R_s = 75\ \Omega$, $R_c = 500\ \Omega$ and $R_e = 1$ kΩ. Assume that the transistor is

properly biased with following parameters $h_{fe} = 100$ and $h_{ie} = 1{\cdot}1$ kΩ.

(i) Compute midband voltage gain of amplifier.

(ii) Find the value of C_z so that the lower 3-dB frequency of circuit approximately equals 50 Hz. 4



SECTION C

7. (a) What causes slew rate limitation in op-amp? Discuss slew rate equation and effect of slew rate in practical application. How does slew rate vary with supply voltage and closed loop gain? 4

(b) Draw the circuit of instrumentation amplifier using a transducer bridge. Show that output voltage of amplifier is directly proportional to the change in resistance of transducer. 4

8. (a) What is zero crossing detector (ZCD)? Explain how Schmitt trigger overcomes the problem of noise generally encountered in ZCD. 4

(b) Draw circuit diagram of all pass filter. In this circuit, take $R = 15{\cdot}9$ kΩ, $C = 0{\cdot}01$ μF and $R_1 = R_F = 10$ kΩ. Find the phase angle of the frequency of input signal equal to 1 kHz. 4

9. (a) Design a practical integrator circuit to properly process input waveform upto 1 kHz. 4

(b) Explain briefly about the condition for maintaining oscillations in an oscillator. Draw the circuit of Wiebridge oscillator using op-amp and derive an expression for its frequency of oscillation. 4

B.Tech. (EC) (V Sem.)

615 **Paper 5.4**

B.Tech. (EC) (FIFTH SEMESTER) EXAMINATION, DECEMBER 2016

(EC)

PAPER 5.4— **Communication Networks**

TIME ALLOWED : THREE HOURS

Maximum Marks— 40

This question paper is divided into three Sections. Students are required to attempt five questions in all, selecting not more than two questions from each Section. All questions carry equal marks.

SECTION A

1. Explain about synchronous and statistical TDMA in detail with neat diagram. 8

2. (i) What do you mean by bit stuffing? Write *one* example. 4

   (ii) Discuss jamming margin in direct sequence spread spectrum with the help of suitable example. 4

3. Write short notes on wireless transmission. 8

Section B

4. Name two well known data transport protocols provided by internet transport layer. Provide a brief description of each service and indicate what type of application might use that service. 8

5. Write short notes on any *two*:—

   (i) FDDI 4

   (ii) CSMA 4

   (iii) Definition of IDU, SDU and PDU. 4

6. Discuss the use of formal analysis techniques for protocols. Comment on why such techniques are used in analysing protocols, and give some examples of types of problems that such an analysis can reveal. 8

Section C

7. Describe the 'token bucket' mechanism for congestion control. With which other technique is token bucket usually combined to achieve complete flow control? What problems in the simplex approach are addressed by using token bucket mechanism? 8

8. What are the different types of error detection methods? Explain CRC error detection technique using generator polynomial.

x^4+x^3+1 and data 11100011. 8

9. Write short notes on any *two*:—

   (i) ATM 4

   (ii) Network layer 4

   (iii) ISDN. 4

B.Tech. (V Sem.)

616 **Paper 5.5**

B.Tech. (FIFTH SEMESTER) EXAMINATION, DECEMBER 2016

(EC)

PAPER 5.5— **Analog Communication**

TIME ALLOWED : THREE HOURS

Maximum Marks— 40

This question paper is divided into three Sections. Students are required to attempt five questions in all, selecting not more than two questions from each Section. All questions carry equal marks.

SECTION A

1. (a) Explain why we need:—

(i) Modulation

(ii) Noise figure

(iii) Communication channels. 6

(b) Write a short note on any *one*:—

(i) Analogue *vs* digital communication

(ii) Continuous and discrete spectra. 2

2. A mixer stage has a noise figure of 9 dB and an available power gain of 15 dB. Calculate overall noise figure referred to the input. 8

3. Define the following and find:—

(i) Noise bandwidth

(ii) Noise in reactive elements. 8

Section B

4. If a base band signal

$$x(f)=2\sin 100t+1\cdot 5\cos 300t$$

is amplitude modulated with carrier signal

$$y(f)=10\sin 3\times 10^{6}t$$

then:—

(i) Draw the frequency spectrum of AM

(ii) Find the overall modulation index. 8

5. Show that in a DSB-modulated signal, the envelope of the resulting band pass signal is proportional to the absolute value of the message signal. This means that an envelope detector can be employed as a DSB demodulator if we know that the message signal is always positive. 8

6. Write short notes on (any *two*):—

(i) Vestigeal sideband modulator

(ii) FM stereo transmitter

(iii) Spectral analysis of different modulations. 8

Section C

7. With the help of a block diagram the working of typical superheterodyne receiver, draw the waveform at the output of each block. 8

8. Write a short note on the following (any *one*):—

(i) Single side band BFO receiver

(ii) AM detector with AGC. 8

9. Draw the circuit schematic of Foster-Seeley phase FM discriminator. Explain its working with the help of phasor diagram. 8

B.Tech. (V Sem.)

617 EC 5.6

B.Tech. (FIFTH SEMESTER) EXAMINATION, DECEMBER 2016

(EC)

PAPER EC 5.6— **Microwave Electronics**

TIME ALLOWED : THREE HOURS

Maximum Marks— 40

Attempt five questions in all, taking not more than two questions from each Section.

All questions carry equal marks.

SECTION A

1. (a) Define following terms for a transmission line:—

(i) Standing wave ratio 2

(ii) Transmission coefficient 1

(iii) Reflection coefficient. 1

(b) A transmission line has a characteristic impedance of $(50+j0\cdot01)\ \Omega$ and is terminated in a load impedance of $(73-j42\cdot5)\ \Omega$. *Calculate:—*

(i) the reflection coefficient 2

(ii) the standing wave ratio. 2

2. Explain construction and uses of Smith Chart. 6+2

3. Explain:—

(a) Single and double stub matching and find out expression for length of stub for impedance matching. 6

(b) Working of balun. 2

Section B

4. Write down working and S-matrix of following components:—

(a) Two hole directional coupler 4

(b) Four port circulator. 4

5. (a) Explain Transverse electric modes in circular waveguide and find out expression for frequency of wave in circular waveguide. 5

(b) An air-filled circular waveguide has a radius of 2 cm and is to carry energy at a frequency of 10 GHz. Find all the TE_{np} and TM_{np} modes for which energy transmission is possible. 3

6. (a) Explain power transmission in circular waveguide. 3

(b) Why does TEM mode not exist in a hollow waveguide? 2

(c) How can TE_{11} mode and TM_{01} mode be excited in circular waveguide? 3

Section C

7. (a) Write limitations of conventional vacuum tubes. 2

(b) Write working of reflex klystron and calculate its efficiency. 6

8. Explain working of helix travelling wave tube. How many wave modes are possible in it? Find out gain of helix TWT in decibels. 8

9. Write short notes on the following:—

(a) IMPATT diode 4

(b) TRAPATT diode. 4

(b) Write short notes (any *two*):—

(i) Electronic Commutator

(ii) T1 carrier system

(iii) Bit/Byte inter leaving

(iv) TDM hierarchy. 2+2=4

B.Tech. (V Sem.)

618 **Paper EI 5.4**

B.Tech. (FIFTH SEMESTER) EXAMINATION, DECEMBER 2016

(EI)

PAPER EI 5.4— **Communication Engineering**

TIME ALLOWED : THREE HOURS

Maximum Marks— 40

The paper is divided into three Sections. Students are required to attempt five questions in all, selecting not more than two questions from each Section.

All questions carry equal marks.

SECTION A

1. (a) The signal $v(t)=[1+0\cdot2\cos(\omega_M/3)t]\cos\omega_c t$ is demodulated using a square-law demodulator having the characteristic $v_0(t)=[v(t)+2]^2$. The output $v_0(t)$ is then filtered by an ideal low-pass filter having a cutoff frequency at f_m Hz. Sketch

the amplitude–frequency characteristics of the output waveform in the frequency range $0 \leq f \leq f_M$. 4

(b) Find the transmission power efficiency for a tone modulated signal when modulation index is 0·25, 0·5 and 0·75. 2

(c) Explain in detail AM transmitter with the help of a block diagram. 2

2. (a) The input to an envelope detector of a tone modulated signal is given as:—

$$v(t) = A_c [1 + A_m \cos \omega_M t] \cos \omega_C t.$$

Find the maximum value of time constant RC of the detector that can always follow the message envelope. 4

(b) Explain the difference between DSB-SC and SSB-SC modulation techniques on the basis of their technical specifications and spectrum. Also explain any one modulator of DSB-SC and SSB-SC techniques. 4

3. (a) Consider a modulating signal $m(t) = 2 \sin (2\pi 10^3 t)$ which is used to modulate a carrier of frequency 10^6 Hz. Find the bandwidth for (i) phase modulation and frequency modulation for above, also (ii) when modulating frequency is doubled

and (iii) when amplitude of modulating signal is halved, thereafter. Use $\beta_p = 10$ and $\beta_f = 10$ units. 4

(b) Explain the generation of a FM signal using Armstrong's method in detail with the help of a block diagram. 4

Section B

4. (a) Explain sampling theorem along with its proof. 2

(b) A signal

$$m(t) = 2 \cos 6000\pi t + 4 \cos 8000\pi t + 6 \cos 10000\pi t.$$

is to be truthfully represented by its samples. What is the minimum sampling rate from (i) low pass sampling theorem consideration and (ii) band pass consideration? 2

(c) Explain Pulse Amplitude Modulation (PAM), Pulse Width Modulation (PWM) and Pulse Position Modulation (PPM). Is there any difference between PAM and sampling? Explain, if any. 4

5. (a) What is Delta Modulation? Explain in detail about the techniques used for this type of modulation. What is the major difference between delta modulation and adaptive modulation? 3+2=5

(b) What do you mean by quantization? Explain its significance. What is quantization error and how can it be minimized? 3

6. (a) What is BPSK technique? Explain in detail with the help of waveforms, modulator and detection techniques along with signal space diagram. 4

(b) Sketch the waveforms of ASK, PSK and FSK for the signals:—

(i) 100011001

(ii) 011100010

(iii) 00000101

(iv) 11111101 4

Section C

7. (a) An analog signal is bandlimited to B Hz, sampled at the Nyquist rate, and the samples are quantized into 4 levels. The quantization levels Q_1, Q_2, Q_3 and Q_4 (messages) are assumed independent and occur with probabilities $P_1=P_4=\frac{1}{8}$ and $P_2=P_3=\frac{3}{8}$. Find the information rate of the source. 3

(b) Five source messages are probable to appear as $m_1=0\cdot4, m_2=0\cdot15, m_3=0\cdot15, m_4=0\cdot15, m5=0\cdot15$. Find coding efficiency for (i) Shannon-Fano coding, (ii) Huffman coding. 3

(c) Is coding efficiency of Shannon-Fano coding better than Huffman coding? Justify your answer with reasons and example. 2

8. (a) Find capacity of Gaussian channel of bandwidth 4 kHz with noise PSD 10^{-9} W/Hz when signal energy is (i) 0·1 J and (ii) 0·001 J. (iii) How does channel change in (ii) if bandwidth is increased to 10 kHz? 4

(b) Show that $H(X, Y)=H(X/Y)+H(Y)$. 2

(c) For a television transmission, the required number of brightness levels=16, pixels per picture frame=10^6, frames transmitted per second=30 and SNR=30 dB. Find the minimum bandwidth required. 2

9. (a) Consider the channel diagram in Fig 1. If $P(x_1)=\alpha$, $P_{12}=P_{21}=\beta$, find the channel capacity. 4

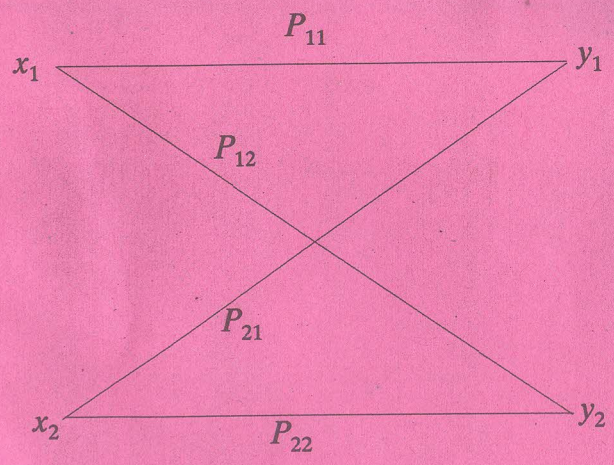


Fig 1.

(b) Explain theory and working of LCDs. Describe the difference between light scattering and field effect types of LCDs. Also explain the advantages of LCDs. 4

8. (a) Compare the advantages and disadvantages of electrical type of level gauges using resistance, inductance and capacitance. Explain capacitance level gauge method in detail. 4

(b) Write short notes on following:—

(i) Float type level indicator

(ii) Displacer

(iii) Hydra step system. 4

9. (a) Explain the working and circuit arrangements for a seven-segment numeric display using LEDs. 4

(b) Write short notes on following:—

(i) Flat panel CRT

(ii) Electro-phoretic displays

(iii) Alpha numeric displays. 4

B.Tech. (V Sem.)

B.Tech. (FIFTH SEMESTER) EXAMINATION, DECEMBER 2016

(EI)

PAPER EI 5.5 — **Transducers**

TIME ALLOWED : THREE HOURS

Maximum Marks— 40

The question paper is divided into three Sections. Students are required to attempt five questions in all, selecting not more than two questions from each Section.

All questions carry equal marks.

SECTION A

1. (a) Explain the different selection criteria for transducers pertaining to specific applications. 2

(b) Differentiate between the following with suitable examples:—

(i) Active and passive transducers

(ii) Analog and digital

(iii) Output and inverse. 3

(c) Describe the different methods used for compensation and cancellation of the effects of temperature changes which affect the resistance elements used in strain gauge bridges. 3

2. (a) A strain gauge is bonded to steel beam 0·25 m long and has a cross-sectional area of $0{\cdot}4\times10^{-3}\ m^2$. Young's modulus of elasticity for steel is 207 GN/m^2. The strain gauge has unstrained resistance of 240 Ω and a gauge factor of 2·2. When the load is applied, the gauge's resistance changes by 0·013 Ω. Calculate the changes in length of the steel beam and the amount of force applied to the beam. 4

(b) Describe the construction, theory and working of thermocouples. Describe the different types of compensations used and also the methods of measurement of their output voltage. 4

3. (a) Describe the following methods used for the measurement of pressure using:—

(i) Pirani gauge

(ii) Bourdon gauge

(iii) Bellows

(iv) Vacuum gauge. 4

(b) Describe different methods used for the measurement of differential pressure. Explain *one* of the best methods in detail. 4

Section B

4. (a) Discuss in detail the construction and working of Rotameter and Pitot tube type flowmeter. Also compare their advantages and disadvantages. 4

(b) Discuss the nuclear radiation method for the measurement of thickness. Enumerate its merits and demerits. 4

5. (a) Differentiate between the methods used for the measurement of thickness for magnetic and non-magnetic materials. Explain eddy current transducer method for measurement of thickness in detail. 4

(b) Explain the working of mass flowmeter. List its advantages and disadvantages. 4

6. (a) Write short notes on the following:—

(i) Venturi tube

(ii) Positive displacement meter

(iii) Flow nozzle

(iv) Orifice plate. 4

(b) What are the methods used for solid flow measurement? Explain any *one* in detail. Also discuss the methods of calibration of flowmeters. 4

Section C

7. (a) Explain the Geiger Muller tube method for the measurement of liquid level. Discuss its merits and demerits in comparison to ultrasonic method. 4

B.Tech. (V Sem.)

620 Paper 5.6

B.Tech. (FIFTH SEMESTER) EXAMINATION, DECEMBER 2016

PAPER EI 5.6 — DIGITAL SIGNAL PROCESSING

TIME ALLOWED : THREE HOURS

Maximum Marks— 40

The question paper is divided into three Sections. Students are required to attempt five questions in all, selecting not more than two questions from each Section.

All questions carry equal marks.

SECTION A

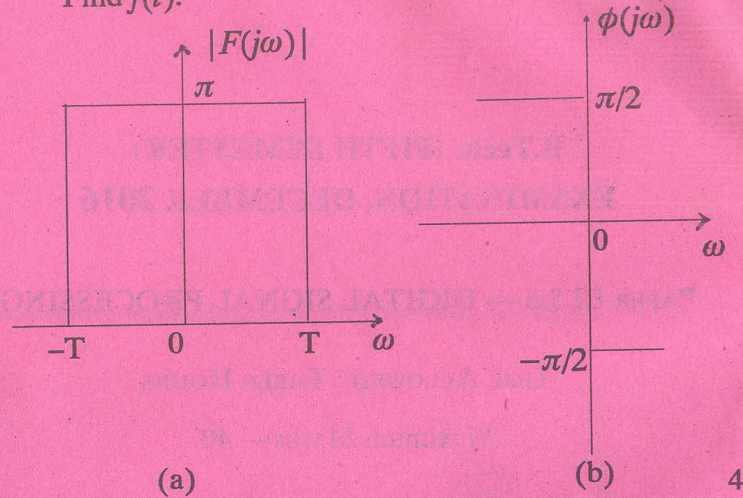
1. (a) Compute the signal energy for $x(t)=e^{-4t}\,u(t)$:—

$$u(t)=\begin{cases}1, & \text{for } t\geq 0\\ 0, & \text{for } t<0\end{cases}$$ 2

(b) Determine the signal energy and signal power for the following complex valued signal and determine whether it is an energy signal or power signal:—

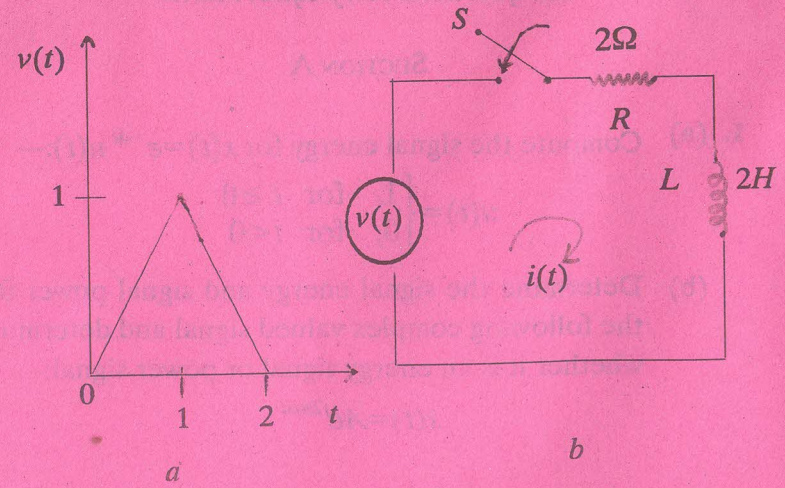
$$x(t)=Ae^{j2\pi at}$$ 2

(c) The magnitude $|F(j\omega)|$ and the phase $\phi(\omega)$ of the Fourier transform of a signal $f(t)$ are shown in fig. Find $f(t)$.



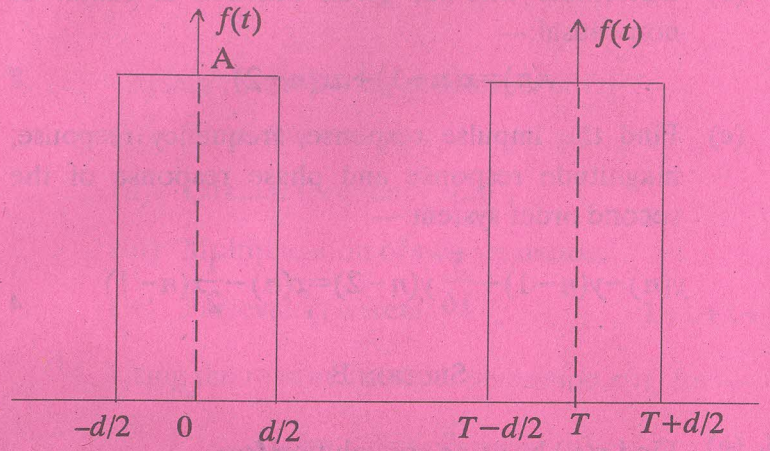
(a) (b) 4

2. (a) A triangular wave shown in fig (*a*) is applied as input to a series *RL* circuit shown in fig. (*b*). Find the current $i(t)$.

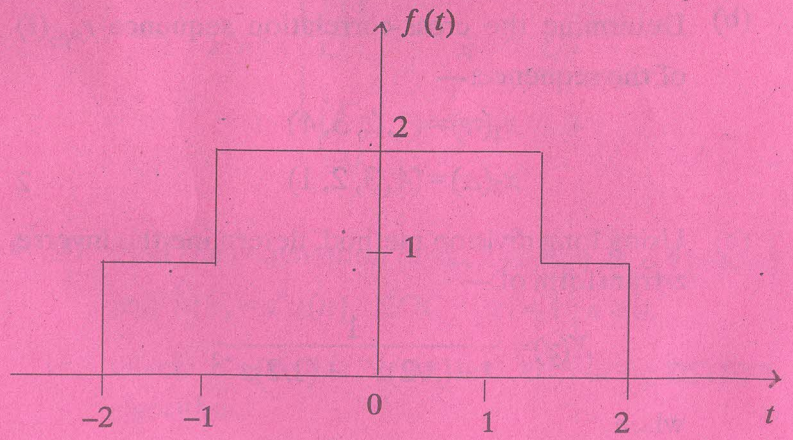


a *b*

(b) Deduce the Fourier series for the waveform of a positive going rectangular pulse train shown in fig.



(c) Find the Fourier transform of the signal given below:— 2



3. (a) Determine the linearity for the given function:—

$$y(t)=7x(t)+5$$ 2

(b) Determine whether given function is causal or non-causal:—

$$y(n)=x(n-1)+ax(n-2)$$ 2

(c) Find the impulse response, frequency response, magnitude response and phase response of the second order system:—

$$y(n)-y(n-1)+\frac{3}{16}y(n-2)=x(n)-\frac{1}{2}x(n-1)$$ 4

Section B

4. (a) Find $x(n)$ by using convolution for:—

$$X(z)=\frac{1}{\left(1-\frac{1}{2}z^{-1}\right)\left(1+\frac{1}{4}z^{-1}\right)}$$ 2

(b) Determine the cross-correlation sequence $r_{x_1x_2}(l)$ of the sequence:—

$$x_1(n)=(1, 2, 3, 4)$$

$$x_2(n)=(4, 3, 2, 1)$$ 2

(c) Using long division method, determine the inverse z-transform of:—

$$X(z)=\frac{1}{1-(3/2)z^{-1}+(1/2)z^{-2}}$$

when

(i) $ROC: |z|>1$ and

(ii) $ROC: |z|<\frac{1}{2}$ 4

5. (a) Explain the following properties of DFT:—

(i) Time reversal

(ii) Circular frequency shift

(iii) Multiplication of two sequences

(iv) Parseval Theorem. 1+1+1+1

(b) Using the residue method, determine $x(n)$ for:—

$$X(z)=\frac{z}{(z-1)(z-2)}$$ 2

(c) Determine the z-transform of the sequence given by:—

$$x(n)=\begin{cases}2^n, & n<0\\ \left(\frac{1}{2}\right)^n, & n=0, 2, 4\\ \left(\frac{1}{3}\right)^n, & n=1, 3, 5\end{cases}$$ 2

6. (a) Find the convolution of the two signals $x(n)=u(n)$ and $h(n)=a^nu(n)$, $ROC: |\alpha|<1; n\geq 0$. 4

(b) Given $x(n)=\{0, 1, 2, 3\}$, find $X(k)$ using DITFFT algorithm. 4

Section C

7. (a) Convert the analog filter with system function:—

b) A transformer has its maximum efficiency of 0.98 at 15KVA at unity power factor. Compare its all day efficiency for the following load cycles (i) Full load of 20KVA 12 hours/day and no load rest of the day (ii) Full load 4 hours/day and 0.4 full load rest of the day. Assume the load to operate on unity power factor all day.

8. a) Drive an expression for a saving in conductor material in an autotransformer over a two-winding transformer of equal rating.

b) A 240V/120V, 12KVA transformer has full-load unity power factor efficiency of 96.2%. It is connected as a auto-transformer to feed a load at 360V. What is its rating and full-load efficiency at 0.85 power factor lagging?

9. a) Discuss about the conditions to be fulfilled for parallel operation of a 3-phase transformer and draw schematically how a 3-phase transformer can be phased in with another 3-phase transformer.

b) A 3-phase transformer bank consisting of three 1-phase transformers 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 the following connections.

i) Y/Δ

ii) Δ/Y The turns ratio is 12. Neglect losses.

B.Tech. EE(V Sem.)
621 **Paper 5.2**

B.Tech. (FIFTH SEMESTER) EXAMINATION, 2016

PAPER 5.2 - Electrical Machine- 1

Time Allowed : 3 HOURS

Maximum Marks : 40

This paper is divided into THREE sections. Attempt FIVE questions in all. Selecting not more than two questions from each Section.

All questions carry equal marks.

SECTION-A

1. Two coupled coils have self and mutual-inductances of

$L_{11} = 2 + \frac{1}{2x}$, $L_{22} = 1 + \frac{1}{2x}$; $L_{12} = L_{21} = \frac{1}{2x}$ over a certain range of linear displacement x. Find the expression for the time average force of field origin at x=0.5m if:

a) Both coils are connected in parallel across a voltage source of $100_{cos}314t$ V

b) Both coils are connected in series across a voltage source of 100cos 314t V

c) Coil 2 is shorted and coil 1 is connected to a voltage source of 100cos 314t V

d) Both coils are connected in series and carry a current of 0.5cos 314t A

2. Self and Mutual – inductances in henrys of two coupled coils are

$L_{11}=3+\frac{1}{2x}$; $L_{22}=2+\frac{1}{2x}$; $L_{12}=L_{21}=\frac{1}{2x}$ over a certain range of linear displacement x in meters.

The coil resistances are negligible. The first coil is excited by a constant current of 10A and the second by a constant current of -5A. Find

a) The mechanical work done in increasing x from 0.5 to 1m

b) The energy supplied by each electrical source in part (a)

c) Change in field energy in part (a)

d) Verify that the sum of the energies associated with mechanical work done and field energy is equal to the energy supplied by both sources during the motion from x=0.5 to x=1m.

3. a) Define field Energy and coenergy. Prove that field energy and coenergy in a linear magnetic system are given by identical expression.

b) Why most practical energy conversion devices use magnetic field as the coupling medium between electrical and mechanical systems?

SECTION-B

4. a) Why do we need a compensating windings to nearly overcome the armature reaction and how is this winding excited and why?

b) A 75KW, 250V compound dc generator has the following data : $R_a=0.04\,\Omega$, $R_{se}=0.004\,\Omega$ $R_f=100\,\Omega$, Brush voltage drop, $V_b=2V$ (1V per brush). Compare the generator induced emf when fully loaded in i) long shunt compound (ii) short shunt compound.

5. a) Compare the speed torque characteristics of a series and cumulative compound motor. Why does the compound motor have a definite no-load speed?

b) A 400V series motor has a total armature resistance of $0.25\,\Omega$ When running at 1200 rpm it draws a current of 25A. When a regulating resistance of $2.75\,\Omega$ is included in the armature circuit, it draws current of 15A. Find the speed and ratio of the two mechanical outputs. Assume that the flux with 15A is 70% of that with 25A.

6. a) Describe Swinburne's test with the help of a neat diagram to find out the efficiency of a d.c machine. What are the main advantages and disadvantages of this test?

b) The magnetizing characteristics of a 4-pole dc series motor may be taken as proportional to current over a part of the working range, on this basis the flux per pole is 4.5mWb/A. The load required a gross torque proportional to the square of the speed equal to 30Nm at 1000rev/min. The armature is wave wound and has 492 conductors. Determine the speed at which the motor will run and the current it will draw when connected to a 220V supply, the total armature resistance of the motor being $2.0\,\Omega$

SECTION-C

7. a) State and prove the condition from maximum efficiency of a transformer.

B. Tech. (V Sem.)
622 **Paper 5.4**

B. Tech. (FIFTH SEMESTER) EXAMINATION, 2016

(EE)

Paper EE 5.4 - POWER ELECTRONICS

Time Allowed : 3 HOURS

Maximum Marks : 40

Attempt FIVE questions in all, selecting not more than TWO questions from each Section.

All questions carry equal marks.

SECTION-A

1. a) Explain the static characteristics of SCR.

   b) Explain the operational characteristics of MOSFET & IGBT.

2. a) Describe the gate protection of SCR.

   b) Name the turn ON methods of SCR. Explain RC firing circuit.

3. a) Snubber circuit for an SCR should primarily consist of capacitor only. But, in actual practice, a resistor is used in series with the capacitor. Discuss.

   b) Show that string efficiency for two parallel connected SCRs is usually less than one. Discuss the problems associated with the parallel operation of SCRs and how these are overcome.

SECTION-B

4. a) Explain the resonant pulse commutation of thyristors.

   b) For impulse commutation of SCR the value of circuit parameter are V_s=230V, L=20 μH and C=40 μF. For constant load current of 120A, calculate peak value of current through capacitance and also through main and auxiliary thyristos/SCRs.

5. a) Explain the operation of single phase full wave controlled bridge converter for RLE load.

   b) Explain the operation of three phase converters with suitable wave forms.

6. a) Explain the effect of source impedance on performance of single phase bridge converter.

   b) A 3-phase full converter bridge is connected to supply voltage of 230V per phase and a frequency of 50Hz. The source inductance is 04mH. The load current on dc side is constant at 20A. If the load consists of a dc voltage of 400V having an internal resistance of 1 Ω, then calculate: i) Firing angle delay and ii) Overlap angle in degrees.

SECTION-C

7. a) Explain the three phase VSI for 120^0 mode operation.

   b) Analyse the waveforms of single phase inverter output voltage using fourier analysis.

8. a) Name the PWM techniques used in inverters. Explain any one technique.

   b) Explain the single phase CSI with ideal switches.

9. a) Discuss the operating principle of single phase step-up cyclo converters.

   b) Explain the operation of three phase to three phase cyclo converters using three phase half wave circuits.

B.Tech. (V Sem.)

623 **Paper EE 5.5**

B.Tech. (EE) (FIFTH SEMESTER) EXAMINATION, DECEMBER 2016

PAPER EE 5.5— ELEMENTS OF POWER SYSTEM

TIME ALLOWED : THREE HOURS

Maximum Marks— 40

The question paper is divided into three Sections. Attempt five questions in all, selecting not more than two questions from each Section. All questions carry equal marks.

SECTION A

1. (a) Prove that the inductance of single phase two wire line is:—

$$L = \frac{\mu_0}{\pi} \ln \left(\frac{d}{r'} \right) \text{ H/m}$$

d=distance between the two conductors

r=radius of each conductor.

μ_0=permeability of free space. 4

(b) Determine, taking the effect of ground into consideration, the capacitance of a single phase 50 Hz overhead line 50 km long consisting of two parallel wires each 0·5 cm in diameter and 1·5 m apart. The height of conductors above the ground is 7 m. 4

2. (a) Determine the effect of load power factors (for both lagging and leading) on the voltage regulation in case of short transmission line. 4

(b) The per phase impedance of a short transmission line is $(0{\cdot}3+j0{\cdot}4)\ \Omega$. The sending end line to line voltage is 3300 V and the load at the receiving end is 300 kW per phase at 0·8 power factor lagging. Calculate the receiving end voltage and line current. 4

3. (a) The per phase parameters for a 60 Hz 200 km long transmission line are $R=2{\cdot}07\ \Omega$, $L=310{\cdot}8$ mH and $C=1{\cdot}4774\ \mu$F. The line supplies a 100 MW wye-connected load at 215 kV (line to line) and 0·9 power factor lagging. Calculate the sending end voltage using nominal-π circuit representation. 4

(b) Determine the A, B, C, D parameters of nominal T network and also discuss the phasor diagram in detail. 4

Section B

4. (a) Determine the corona loss in kW of a three phase 220 kV, 50 Hz and 200 km long line of three conductors each of radius 1 cm and spaced 5 m apart in an equilateral triangle formation. The air temperature is 30°C and atmospheric pressure is 760 mm of Hg. The surface irregularity factor is 0·85 and the dielectric strength of air is 30 kV/cm (peak). 4

(b) What are the factors affecting corona? Also discuss the advantages and disadvantages of corona. 4

5. (a) An insulator string for 66 kV line has 4 discs. The shunt capacitance between each joint and metal work is 10% of the capacitance of each disc. Find the voltage across the different discs and string efficiency η. 4

(b) A 33 kV 3-phase underground feeder, 3·4 km long, uses three single core cables. Each cable has a conductor diameter of 2·5 cm and radial thickness of insulation is 0·6 cm. The relative permittivity of dielectric is 3·1 Find:—

(i) Capacitance of cable per phase

(ii) Charging current per phase

(iii) Total charging KVar

(iv) Dielectric loss per phase if the power factor of unloaded cable is 0·03. 4

6. (a) Discuss the effect of ice and wind on the transmission line. What are the different types of vibrations in the transmission line due to unequal ice loading? 4

(b) An overhead transmission line conductor has a weight of 1·15 kg/m diameter of 1·6 cm and an ultimate strength of 30×10^6 kg/m^2 when erected between supports 300 m apart and having a 10 m difference in height Determine the sag with respect to the taller of the two supports if the conductor is loaded 1 kg/m due to ice and factor of safety is 2·0. 4

Section C

7. Write short notes on:—

(a) Design consideration of EHV transmission

(b) HVDC system

(c) Insulation design

(d) Bundled conductor. 2×4=8

8. (a) What are the different types of DC links used in the HVDC transmission system? 4

(b) Discuss the necessity of EHV transmission and problem associated with EHV AC transmission system. 4

9. (a) A 200 kV, 3-phase, 60 Hz transmission line 200 km long consists of three conductors of effective diameter of 3 cm arranged in a vertical plane with 5 m spacing and regularly transposed. Find the inductance and kVA rating of the arch suppression coil in the system. 4

(b) What are the different methods of neutral groundings used? Discuss in detail. 4

B.Tech. (EE) (FIFTH SEMESTER) EXAMINATION, DECEMBER 2016

PAPER EE 5.6 — **Network Analysis**

TIME ALLOWED : THREE HOURS

Maximum Marks— 40

Attempt five questions in all, selecting not more than two from each Section. All questions carry equal marks.

SECTION A

1. (a) Explain cut-set schedule.

   (b) Obtain cut-set matrix for the circuit shown. Then obtain equilibrium equations on voltage basis. 2+6

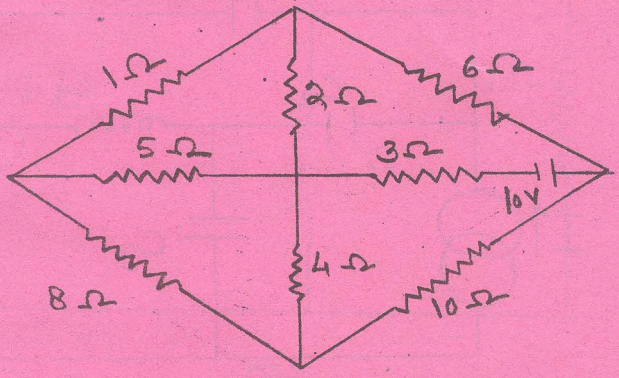


Fig. 1

2. (a) Obtain three trees for the network shown in Fig. 2

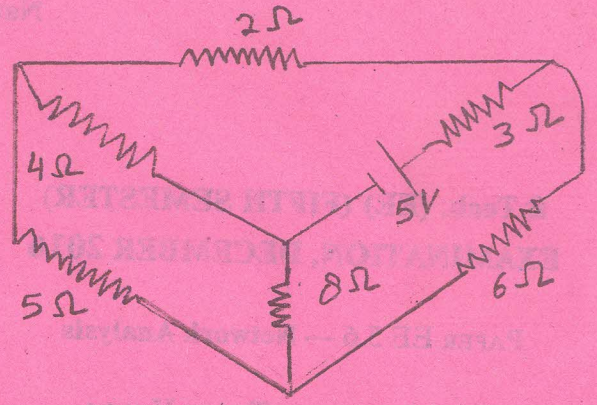


Fig. 2

(b) Obtain tie-set matrix for one of the trees obtained in (a) and then obtain equilibrium equations on current basis. 2+6

3. (a) Obtain Dual network for the network shown in Fig. 3.

(b) Write mesh equations for the given network and nodal equations for the dual network. 4+4

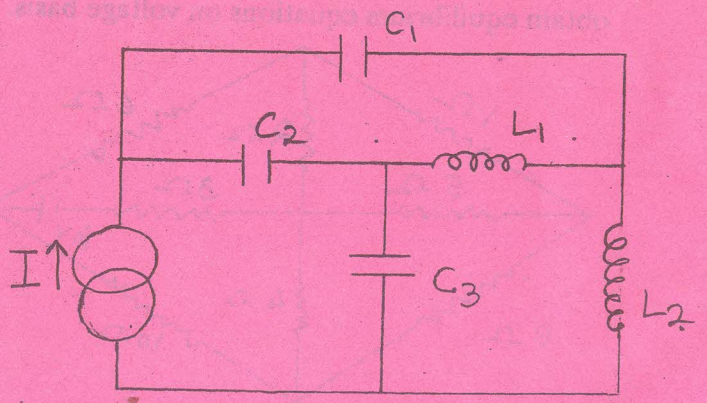


Fig. 3

SECTION B

4. (a) Explain Superposition Theorem.

(b) Find the current I in 10 Ω resistance by superposition theorem (Fig. 4). 2+6

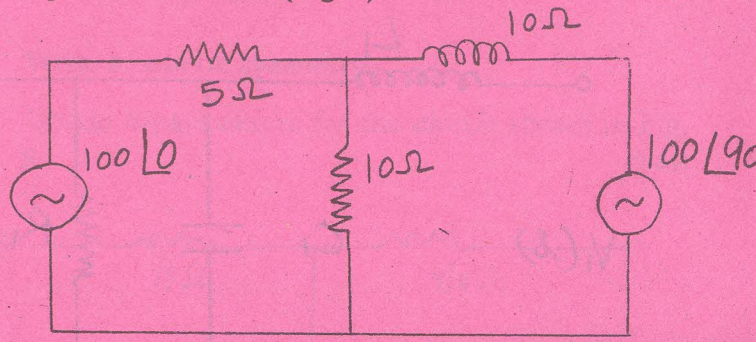


Fig. 4

5. (a) State Thevenin's Theorem.

(b) Using Thevenin's theorem find the power in 1 Ω resistor. (Fig. 5) 2+6

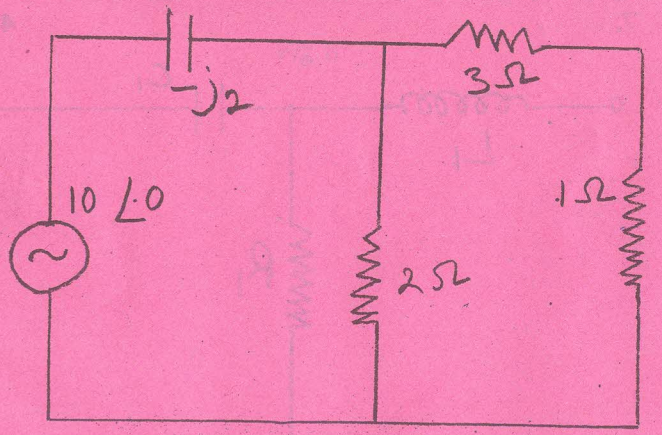


Fig. 5

6. (a) Enumerate the properties of transfer functions.

(b) For the given network in Fig. 6 obtain driving point impedance $z_{11}(s)$ and transfer functions $G_{21}(s)$ and $Z_{21}(s)$. 4+4

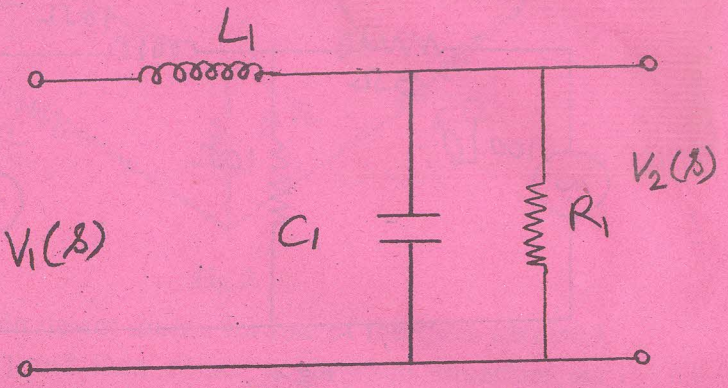


Fig. 6

SECTION C

7. (a) Obtain inter-relation between z and h parameters.

(b) Obtain y-parameters for the circuit shown in Fig. 7. 4+4

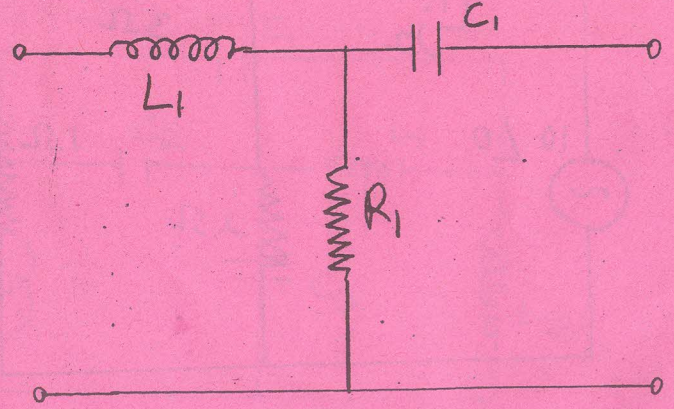


Fig. 7

8. (a) Enumerate the methods by which two two-port networks can be inter-connected.

(b) Derive results for series connection of two two-port networks. 2+6

9. (a) Write a note on symmetry.

(b) Obtain h-parameters for the circuit shown in Fig. 8. 2+6

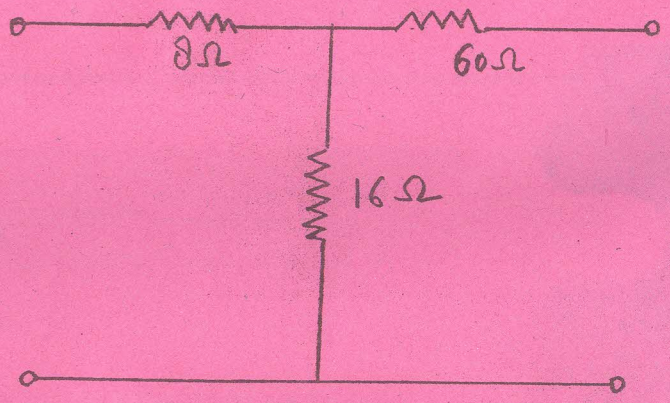


Fig. 8

9. Describe the process of humoral immune response with the help of suitable diagram.

प्रतिरक्षा प्रतिक्रिया क्रिया का सचित्र वर्णन कीजिये ।

B.Tech. (B.T.) (V Sem.)

625 Paper 5.2

B.Tech. (B.T.) (FIFTH SEMESTER) EXAMINATION, DECEMBER 2016

PAPER 5.2— **Microbiology and Immunology**

TIME ALLOWED : THREE HOURS

Maximum Marks— 40

Attempt five questions in all, selecting not more than two questions from each Section.

All questions carry equal marks.

कुल पाँच प्रश्न करने हैं। प्रत्येक खण्ड में से दो से अधिक प्रश्न नहीं किये जा सकते हैं।

सभी प्रश्नों के अंक समान हैं।

SECTION A (खण्ड अ)

1. Explain the cell wall of gram negative bacteria with the help of suitable diagrams.

ग्राम निगेटिव जीवाणुओं की कोशिका भित्ति का सचित्र वर्णन कीजिये ।

2. Write short notes on the following:—

(a) Transformation in bacteria

(b) Classification of fungi by Alexopoulos.

निम्नलिखित पर संक्षिप्त टिप्पणी लिखिये:—

(a) जीवाणुओं में परिवर्तन की क्रिया

(b) एलेक्जोपोलस द्वारा कवकों का वर्गीकरण।

3. Write short notes on the following:—

(a) General morphology of viruses

(b) Characteristics of fungi.

निम्नलिखित पर संक्षिप्त टिप्पणी लिखिये:—

(a) विषाणुओं की सामान्य संरचना

(b) कवकों की विशेषताएँ।

Section B (खण्ड ब)

4. Explain the industrial application of microorganisms in food and medicine.

सूक्ष्मजीवों का दवाइयों एवं खाद्य पदार्थों में औद्योगिक महत्त्व का वर्णन कीजिये।

5. Write short notes on the following:—

(a) Physical methods of sterilization.

(b) Selective media with example.

निम्नलिखित पर संक्षिप्त टिप्पणी लिखिये:—

(a) भौतिक क्रिया द्वारा बंध्याकरण

(b) चयनात्मक मीडिया उदाहरण सहित।

6. Write short notes on the following:—

(a) Characteristics of antigens

(b) Difference between innate and acquired immunity.

निम्नलिखित पर संक्षिप्त टिप्पणी लिखिये:—

(a) प्रतिजन की विशेषताएँ

(b) सहज एवं अधिग्रहण क्रिया प्रतिरोधक क्षमता में अन्तर।

Section C (खण्ड स)

7. Explain the production and applications of monoclonal antibodies with the help of suitable diagram.

मोनोक्लोनल एन्टीबाडी के उत्पादन एवं विशेषतओं के बारे में विस्तारपूर्वक लिखिये।

8. Write short notes on the following:—

(a) Types of immunoglobulins

(b) Type-II hypersensitivity.

निम्नलिखित पर संक्षिप्त टिप्पणी लिखिये:—

(a) इम्यूनोग्लोब्यूलिन के प्रकार

(b) अतिसंवेदनशीलता प्रकार-II

B.Tech. (B.T.) (V Sem.)

626 **Paper 5.3**

B.Tech. (FIFTH SEMESTER) EXAMINATION, DECEMBER 2016

BIOTECHNOLOGY

PAPER 5.3— **Metabolic Engineering**

TIME ALLOWED : THREE HOURS

Maximum Marks— 40

This question paper is divided into three Sections. Students are required to attempt five questions in all, taking not more than two questions from each Section.

All questions carry equal marks.

SECTION A

1. What do you mean by metabolic engineering? Explain the metabolic processes and phenomenon that are part of assembly reactions and flueling reactions. 8

2. (a) How can secondary metabolites be differentiated from primary metabolites? Give its importance in medical and agricultural field. 4

(b) What is the role of principal node in flexible and rigid metabolic pathways? 4

3. (a) What is stoichiometry of cellular reaction? Give a generalized equation for different components (substrate, metabolic product, intracellular metabolites and biomass) of cellular reactions. 2+2

(b) Explain different mechanisms involved in metabolic regulation at enzymatic level. 4

Section B

4. Give the metabolic pathway synthesis algorithm comprising following reactions:—

(a) $A \rightarrow B$

(b) $B \Leftrightarrow C$

(c) $C \Leftrightarrow D$

(d) $C+D \Leftrightarrow F+K$

(e) $F+K \Leftrightarrow H+E$

(f) $H+D \Leftrightarrow E+F$

(g) $A \Leftrightarrow E$

(h) $E \rightarrow F+G$

(k) $F \Leftrightarrow G$

(m) $G \rightarrow L$

5. (a) Explain different approaches of direct measurement analysis of metabolic flux. 4

(b) Explain metabolic flux control analysis for branched network. 4

6. Write short notes on following:—

(a) Metabolic flux for consumption of carbon and nitrogen substrate.

(b) Concept of regulatory analogs.

Section C

7. Explain the structure of metabolic networks and how metabolic control is important in metabolic engineering. 8

8. (a) What do you mean by gene expression in response to environmental stimuli? 4

(b) Give a conceptual approach to regulation of metabolic fluxes. 4

9. (a) What is localized thermodynamic bottleneck? Explain the criteria for biochemical process to be feasible thermodynamically. 4

(b) The foundation of non-equilibrium thermodynamics is flow-force relationship . How? 4

B.Tech. (V Sem.)

634 **Paper CE 5.7**

B.Tech. (FIFTH SEMESTER) EXAMINATION, DECEMBER 2016

CHEMICAL ENGINEERING

PAPER CE 5.7— **Mass Transfer**

TIME ALLOWED : THREE HOURS

Maximum Marks— 40

*This question paper is divided into three Sections. Students are required to attempt **five** questions in all, selecting not more than **two** questions from each Section.*

All questions carry equal marks.

SECTION A

1. (a) What do you mean by molecular diffusion and eddy diffusion? Explain. 2

   (b) For a binary mixture what factors are involved in the rate of diffusion of a component according to the Fick's law? 2

   (c) A narrow tube is partially filled with a liquid and maintained at a constant temperature. A gentle stream of gas is passing

Turn over

across the open end of the tube. As liquid evaporates, the level drops slowly. At a given time t, the level is z from the top. Derive an equation to calculate the value of diffusivity of the liquid vapour in the gas. 2+2+4 = 8

2. (a) Derive an expression for mass flux of the species A which is diffusing through non-diffusing B in a gas mixture $(A+B)$ under steady state condition. 4

(b) In an oxygen-nitrogen gas mixture at 101·3 KPa pressure and 298K temperature, the concentrations of oxygen at two phases 2 mm apart are 10 and 20% by volume respectively. Calculate the flux of diffusion of oxygen for the cases where:–

(i) the nitrogen is non-diffusing

(ii) there is equimolar counter diffusion of the two gases.

Diffusivity of O_2 in N_2 is $1{\cdot}81 \times 10^{-5}$ m^2/sec.

4+4 = 8

3. (a) What do you mean by interphase mass transfer? 2

(b) Explain the penetration theory. What are the important results of this theory? 3

(c) The gas-phase mass transfer coefficient for the evaporation of a drop of ethyl alcohol in a stream of air at 300 K and 1·2 bar pressure is $K_\infty = 2{\cdot}4 \times 10^{-6} \frac{\text{K mole}}{\text{m}^2.\text{sec.mmHg}}$. Calculate

the value of mass transfer coefficient if the driving force is expressed in terms of difference in mole fraction of alcohol in the gas phase. If the diffusivity of alcohol in air is 0·102 cm^2/sec at 0°C temperature, estimate the thickness of the stagnant gas film. The vapour pressure of alcohol is 0·0877 bar at 300K. 2+3+3 = 8

Section B

4. (a) Derive an equation of operating line for enriching and stripping sections for McCabe-Thiele Method. 4

(b) 1000 kg moles/hr of an ethanol-propane mixture containing 65 mole per cent ethanol is to be separated in a continuous plate column operating at 1 atm pressure. The desired terminal composition in units of mole fraction of ethanol are $x_D = 0{\cdot}92$ and $x_W = 0{\cdot}07$. The feed is saturated vapour and total condenser is used and reflux ratio is given 4. Find the number of theoretical plates required for separation.

Relative volatility of ethanol-propanol system may be taken 2·10. 4+4 = 8

5. (a) What is the difference between an operating line and equilibrium curve? 2

(b) Define relative volatility. What is role of relative volatility in distillation? 2

(c) Geraniol ($C_{10}H_{18}O$) is an essential oil of commercial value. It is conventionally purified by steam distillation. A pilot scale unit is charged with 0·5 kg crude geraniol containing a small amount of non-volatile impurities. Live saturated steam at 105°C is passed through the still at rate of 20 kg/hr. Calculate the distillation time assuming that geraniol is immiscible with water. Neglect condensation of steam. The vaporization efficiency is 0·8, vapour pressure of water at 105°C is 1·211 bar and that of geraniol (A) is given by

$$\log_e \rho_A^V = 21{\cdot}1 - \frac{7217}{T},$$

where ρ_A^V is in mm Hg and T in Kelvin. 2+2+4 = 8

6. (a) Write the properties of solvent selected for gas absorption. 2

(b) Derive the relation z = (NTU)×(HTU) for case of absorption of gases in packed bed, where z is total height of bed. 4

(c) Explain the term "Absorption factor". 2

Section C

7. (a) What do you mean by drying? Write the factors affecting the drying rate. 4

(b) A wet solid is to be dried from 35% to 10% moisture under constant drying condition in five hours. If the equilibrium moisture content is 4% and the critical moisture content is 14%, how much time will it take to dry solids to 6% moisture under same condition? 4+4 = 8

8. (a) Explain azeotropic mixtures and write its type with example. 4

(b) Explain azeotropic distillation with suitable example. 4+4 = 8

9. Write short notes on following (any *two*):–

(a) Crystallization

(b) Liquid-liquid extraction

(c) Adsorption. 4×2 = 8

B.Tech. (BT) (V Sem.)

628 Paper 5.5

B.Tech. (BT) (FIFTH SEMESTER) EXAMINATION, DECEMBER 2016

BT

PAPER 5.5— **Enzyme Engineering and Technology**

TIME ALLOWED : THREE HOURS

Maximum Marks— 40

Attempt five questions in all, taking not more than two questions from each Section.

All questions carry equal marks.

SECTION A

1. Briefly explain the following:—

   (a) General rules for nomenclature of enzyme 2

   (b) Koshland "Induced-fit" Hypothesis 2

   (c) Significance of Michaelis Menten equation 2

   (d) Ping-Pong bi-bi mechanism. 2

Turn over

2. Write significance of Hofstee's plot. Explain different methods used for investigating kinetics of enzyme catalyzed reaction. 2+6=8

3. Explain the following:—

(a) Mechanism of chymotrypsin 4

(b) Kinetics of non-competitive inhibition. 4

Section B

4. Briefly explain the following:—

(a) Gel filtration chromatography 2

(b) Homotropic cooperativity and Hill equation 2

(c) Metal activated enzymes 2

(d) Enzymes from Extremophiles. 2

5. Write mechanism of Thiamine pyrophosphate. Explain regulation by metabolic compartmentation. 8

6. Explain the following:—

(a) Modification of catalytic property by genetic engineering 4

(b) Extraction methods for membrane bound enzyme. 4

Section C

7. Briefly explain the following:—

(a) Proteolytic enzyme 2

(b) Cyclodextrin 2

(c) Lipase 2

(d) Methods of immobilization. 2

8. Write industrial application of penicillin acylase. Explain kinetics of immobilized batch bioreactor. 8

9. Explain the following:—

(a) Role of enzyme in animal nutrition and molecular biology

(b) Effect of solute partition on kinetics of immobilized enzyme.

B.Tech. (FIFTH SEMESTER) EXAMINATION, DECEMBER 2016

BIO-TECHNOLOGY

PAPER 5.4— Genetics and Genetic Engineering

TIME ALLOWED : THREE HOURS

Maximum Marks— 40

Attempt five questions in all, selecting not more than two questions from each Section. All questions carry equal marks.

Section A

Q.1. What is Recombination frequency? Summarize the importance of recombination frequency in genetic studies and give a method for its measurement.

Q.2 What are mutagens? Describe different types of physical and chemical mutagens

Q.3. Write notes on the following

a) Dosage compensation b) Law of independent assortment

Section B

Q.4 Describe various features of the gene cloning vector pBR322. How this vector was developed in the laboratory?

Q.5. Explain the following

a) Electroporation b) Restriction endonucleases used in genetic engineering

Q.6 Compare and contrast the methods of DNA isolation from prokaryotic and eukaryotic cells

Section C

Q.7 Write notes on the following

a) Sex linked diseases b) Functional screening of clones

Q.8 Give a general overview of the current techniques of genetic analysis

Q.9 Write notes on the following

a) Human genome project b) Identical and fraternal twins

B.Tech. (FIFTH SEMESTER) EXAMINATION, DECEMBER 2016

CHEMICAL ENGINEERING

PAPER 5.2— Computational Methods in Engineering

TIME ALLOWED : THREE HOURS

Maximum Marks— 40

Attempt five questions in all, selecting not more than two questions from each Section. All questions carry equal marks.

SECTION A

Q.1. Convert the following set of equations in *Diagonally Dominant* form and then apply *Successive Displacement* method to the equations. Take zero as initial guess. Carry out at least five iterations. **[8]**

$$\begin{bmatrix} -2 & 5 & 1 \\ 2 & -1 & 5 \\ 15 & -3 & 8 \end{bmatrix} \begin{bmatrix} x^3 \\ xy^2 \\ zx^2 \end{bmatrix} = \begin{bmatrix} 21 \\ 13 \\ 27 \end{bmatrix}$$

Q.2. Carry out Householder's Transformation on the matrix A to convert it into tri-diogonal matrix. **[8]**

$$A = \begin{bmatrix} 1 & 3 & 4 \\ 3 & 1 & 2 \\ 4 & 2 & 1 \end{bmatrix}$$

Q.3. Solve the following set of equations using *Newton-Raphson* Technique. **[8]**

Given $Y^{(0)} = [y_1^{(0)} \; y_2^{(0)}] = [0.5 \;\; 0.5]$.

$$f_1(Y) = 4 - 8y_2 + 4y_3 - 2y_2^3 = 0$$
$$f_2(Y) = 1 - 4y_2 + 3y_3 + y_3^2 = 0$$

SECTION B

Q.4. Following table gives the effect of aromatic concentration, C_A (kg.mol/m^3), on **[8]**

the rate, r_A, $(kgmol/m^2hr)$, of coke formation on a metal plate during pyrolysis of naphtha in a jet stirred reactor at 1083 K. Determine the order of reaction using expression $r_A = kC_A^n$ and *Least Square fitting* technique.

$10^4 C_A$	1.79	2.03	2.22	2.47	2.97	3.39	4.95	7.37	9.01	9.83	10.07
$10^4 r_A$	0.28	0.32	0.36	0.40	0.49	0.59	0.99	1.55	2.00	2.25	2.60

Q.5. A student obtained following data between tracer concentration C and time t by injecting a pulse of tracer in a closed vessel during RTD experiment. The mean residence time(t) was calculated by him using the equation: **[3+5]**

$$t = \frac{\int_0^\infty tCdt}{\int_0^\infty Cdt} \cong \frac{\sum C_i t_i \Delta t}{\sum C_i \Delta t}$$

t_i (min)	0	1	2	3	4	5	6	7	8	9	10	12	14
C_i (g/m^3)	0	1	5	8	10	8	6	4	3	2.2	1.5	0.6	0

(a) Calculate t using the above equation.

(b) Apply 1/3 Simpson's Rule on the given data to find t.

Q.6. Solve the following Initial Value Problem for $y(0.04)$ and h=0.02 using *Classical Runge-Kutta* method. **[8]**

$$\begin{bmatrix} y_1' \\ y_2' \end{bmatrix} = \begin{bmatrix} -100y_1 \\ 2y_1 - y_2 \end{bmatrix} \quad with \quad y_0 = \begin{bmatrix} 2 \\ 1 \end{bmatrix}$$

SECTION C

Q.7. Solve the given boundary-value problem using *finite-difference* method to determine $y(0.5)$ **[8]**

$$\frac{d^2y}{dx^2} + y + 1 = 0, \qquad 0 \le x \le 1$$

where $y(0) = 0$, $y(1) = 0$ with h=0.25. Also, compute the absolute error by comparing the answer with true solution.

Q.8. Using *Shooting Technique* along with *Heun's method*, solve the following Boundary Value Problem and find $y(1.5)$ **[8]**

$$\frac{d^2y}{dx^2} = 6x,$$

Subject to: $y(1) = 2,\ y(2) = 9\ and\ h = 0.5$

Q.9. Solve the heat equation **[8]**

$$\frac{\partial u}{\partial t} = \frac{\partial^2 u}{\partial x^2}$$

Subject to the conditions:

$u(x,0) = 0;\quad u(0,t) = 0;\quad u(1,t) = t$

Take k=1/16 and h=1/4

B.Tech. (V Sem.)

630 CE 5.3

B.Tech. (FIFTH SEMESTER) EXAMINATION, DECEMBER 2016

CHEMICAL ENGINEERING

PAPER CE 5.3— **Process Instrumentation & Control**

TIME ALLOWED : THREE HOURS

Maximum Marks— 40

Attempt five questions in all, selecting not more than two questions from each Section. All questions carry equal marks. Use of scientific calculator is allowed.

In case of missing data or incorrect information make appropriate assumption and mention it clearly in your answer sheet.

Material required with question paper : mm-mm, semi-log and log-log graph papers.

[Marks]

Section A

Q1. **(a)** Define each within 50 words. Secondary measurements, Dead zone, Noise, Calibration, Resolution sensitivity, Primary instrument & Overall error. **[3+5]**

(b) Find Laplace of $sin(\omega t)$ by direct derivation.

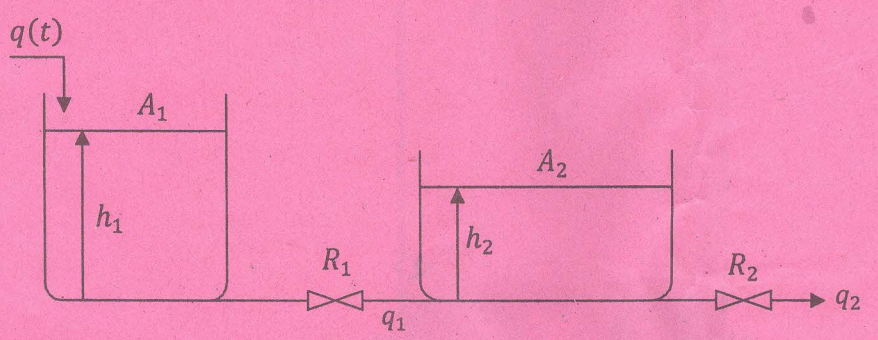
Q2. **(a)** Given $G(s) = (86s - 78)/\{(s+3)(s-4)(5s-1)\}$. Determine $G(t)$. **[5+3]**

(b) Given $2y'' + 3y' - 2y = te^{-2t}$, $y(0) = -1$, $y'(0) = 2$. Determine $y(s)$.

Q3. A mercury thermometer having time constant 0.1 minute is placed in temperature bath at 100 °F and allowed to come in equilibrium with the bath. At time $t = 0$, the temperature of the bath begins to vary in sinusoidal manner about its average temperature 100 °F with an amplitude of 2 °F. If the frequency of oscillation is $10/\pi$ cycles/minute, plot the ultimate response of the thermometer reading as a function of time. What is the phase lag? **[8]**

Section B

Q4. For a interacting system (as shown in the figure) derive the expression $H_2(s)/Q(s)$. **[8]**

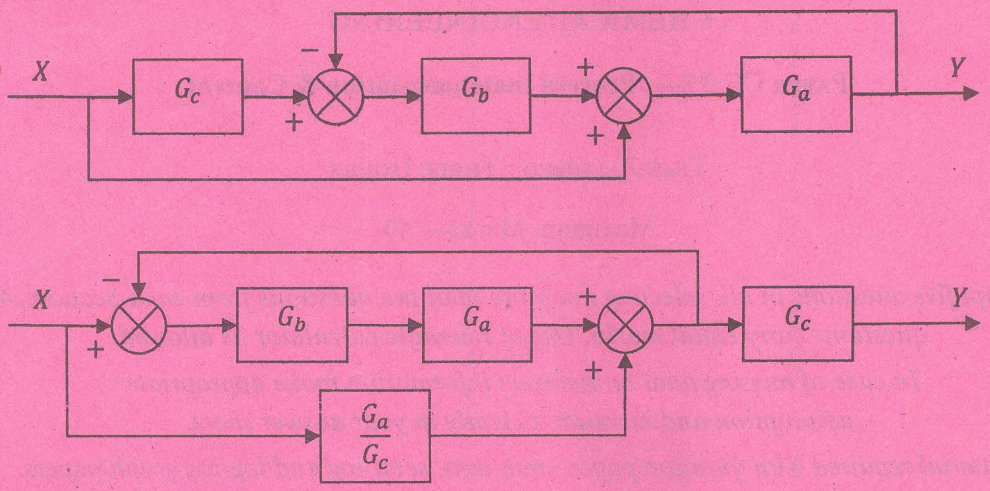


Q5. A unit step change in error (ε) is introduced into a PID controller. If $K_c = 10$, $\tau_I = 1$ and **[8]**

P. T. O.

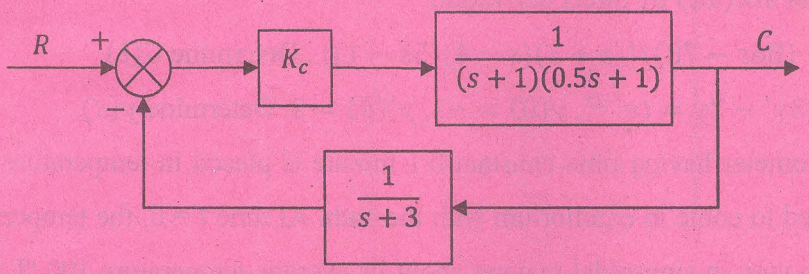
$\tau_D = 0.5$, plot the response of the controller $P(t)$.

Q6. Determine the transfer function $Y(s)/X(s)$ for the following block diagrams. Express results in terms of G_a, G_b and G_c. **[4+4]**



Section C

Q7. Write the characteristic equation and construct the Routh array for the control system shown in the figure. Write your conclusion. Is the system stable for (a) $K_c = 9.5$, (b) $K_c = 11$ and (c) $K_c = 12$? **[8]**



Q8. For the transfer function $100/\{(10s+1)(s+1)\}$ sketch the gain versus frequency, asymptotic Bode diagram. Find the actual gain and phase angle at $\omega = 10$. **[8]**

Q9. How one can use Cohen and Coon rules for controller tuning? **[8]**

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B.Tech. (FIFTH SEMESTER) EXAMINATION, DECEMBER 2016

CHEMICAL ENGINEERING

PAPER 5.4— **Chemical Reaction Engineering – I**

TIME ALLOWED : THREE HOURS

Maximum Marks— 40

Attempt five questions in all, selecting not more than two questions from each Section. All questions carry equal marks.

In case of missing data or incorrect information make appropriate assumption(s) and mention them clearly in answer sheet. Write the answers in sequential order.

Section A

Q. 1 (a) A rocket engine burns a stoichiometric mixture of fuel (liquid hydrogen) in oxidant (liquid oxygen) as

$$H_2 + \frac{1}{2}O_2 \longrightarrow H_2O$$

The combustion chamber is cylindrical, 75 cm long and 60 cm in diameter and the combustion process produces 108 kg/s of exhaust gases. If combustion is complete, find the rate of reaction of hydrogen and of oxygen.

(b) Milk is pasteurized if it is heated to 63°C for 30 min, but if it is heated to 74°C it only needs 15 s for the same result. Find the activation energy of this sterilization process.

(c) On doubling the concentration of reactant, the rate of reaction triples. Find the reaction order.

3+3+2=8

Q. 2 (a) Consider irreversible bimolecular type second order reaction $A + B \longrightarrow product$, carried out in a constant volume batch reactor. For this reaction system prove that

$$\ln\frac{1-X_B}{1-X_A} = \ln\frac{M-X_A}{M(1-X_A)}$$

$$= C_{A0}(M-1)kt = (C_{B0}-C_{A0})kt, \qquad M \neq 1$$

All symbols have their usual meanings.

(b) Derive the performance equation for variable volume batch reactor. Also describe expansion factor in brief with suitable example.

4+4=8

TURN OVER

Q. 3 (a) The irreversible isomerization

$$A \longrightarrow B$$

was carried out in a batch reactor and the following concentration time data were obtained:

t(min)	0	3	5	8	10	12	15	17.5
$C_A(mol/dm^3)$	4.0	2.89	2.25	1.45	1.0	0.65	0.25	0.07

Determine the reaction order and the specific reaction rate.

(b) In an isothermal batch reactor 70% of a liquid reactant is converted in 13 min. What space-time and space-velocity are needed to effect this conversion in a plug flow reactor and in a mixed flow reactor?

4+4=8

Section B

Q. 4 (a) The kinetics of the aqueous-phase decomposition of A is investigated in two mixed flow reactors in series, the second having twice the volume of the first reactor. At steady state with a feed concentration of 1 mol A/liter and mean residence time of 96 sec in the first reactor, the concentration in the first reactor is 0.5 mol A/ liter and in the second is 0.25 mol - A/liter. Find the kinetic equation for the decomposition.

(b) In the autocatalytic reaction, at high and low conversion, suggest the kinds of reactors for efficient performance with suitable diagram and explanations. Also develop the relation for optimum recycle ratio in recycle reactor.

4+4=8

Q. 5 (a) Consider the reaction in series such as

$$A \xrightarrow{k_1} R \xrightarrow{k_2} S$$

Reaction A to R follows first order kinetics and reaction R to S follows zero order kinetics. Also for a plug flow or batch reactor $C_{R0} = C_{S0} = 0$. Derive the expression for maximum concentration of intermediate, $C_{R,max}$, and the time, $t_{R,max}$.

(b) The desired liquid-phase reaction

$$A + B \xrightarrow{k_1} R + T \qquad \frac{dC_R}{dt} = \frac{dC_T}{dt} = k_1 C_A^{1.5} C_B^{0.3}$$

is accompanied by the unwanted side reaction

$$A + B \xrightarrow{k_1} S + U \qquad \frac{dC_S}{dt} = \frac{dC_U}{dt} = k_2 C_A^{0.5} C_B^{1.8}$$

From the standpoint of favorable product distribution, order the following contacting schemes, from the most desirable to the least desirable.

(i) A plug flow reactor

(ii) A plug flow reactor with side stream of B

(iii) A plug flow reactor with side stream of A

(iv) A CSTR.

4+4=8

Q. 6 (a) Between 0°C and 100°C determine the equilibrium conversion for the following elementary aqueous reaction

$$A \Leftrightarrow R, \begin{cases} \Delta G^0_{298} = -14130\, J/mol \\ \Delta H^0_{298} = -75300\, J/mol \end{cases} \qquad C_{pA} = C_{pR} = \text{constant}$$

(i) Present the result in the form of a plot of temperature versus conversion

(ii) What restriction should be placed on the reactor operating isothermally if conversion of 75% or higher is desire?

8

Section C

Q. 7 (a) An RTD analysis was carried out on a liquid-phase reactor. Analyze the following data

$t(s)$	0	150	175	200	225	240	250	260
$C \times 10^3 (g/dm^3)$	0	0	1.0	3.0	7.4	9.4	9.7	9.4

$t(s)$	275	300	325	350	375	400	450
$C \times 10^3 (g/dm^3)$	8.2	5.0	2.5	1.2	0.5	0.2	0

(i) Construct the E(t) curve for these data.

(ii) What fraction of the material spends between 230 and 270 s in the reactor?

(iii) Plot the F(t) curve for these data.

(iv) What fraction of the material spends less than 250 s in the reactor?

8

Q. 8 (a) Develop a RTD equation for N equal tanks in series and show that the number of tank in series as

$$N = \frac{1}{\sigma_\theta^2}$$

All symbols have their usual meanings.

(b) Prove that for a perfectly mixed CSTR

$$\sigma^2 = \bar{t}^2$$

All symbols have their usual meanings.

6+2=8

Q. 9 (a) Consider the dispersed plug flow model with a pulse input into a closed vessel (or closed-closed vessel boundary condition with $\left(\frac{D}{uL}\right)$>0.01) and derive the expression to show dimensionless variance as

$$\sigma_\theta^2 = \frac{\sigma_t^2}{\bar{t}^2} = 2\left(\frac{D}{uL}\right) - 2\left(\frac{D}{uL}\right)^2\left[1 - e^{-uL/D}\right]$$

All symbols have their usual meanings.

(b) An injected slug of tracer material flows with its carrier fluid down a long, straight pipe in dispersed plug flow. At point A in the pipe the spread of tracer is 16 m. At point B, 1 kilometer downstream from A, its spread is 32 m. What do you estimate its spread to be at a point C, which is 2 kilometers downstream from point A?

5+3=8

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B.Tech. (CE) (FIFTH SEMESTER) EXAMINATION, DECEMBER 2016

CHEMICAL ENGINEERING

PAPER 5.6— **Environmental Pollution Control**

TIME ALLOWED : THREE HOURS

Maximum Marks— 40

Attempt five questions in all, selecting not more than two questions from each Section. All questions carry equal marks. Assume suitable data, if required.

Section-A

Q.1 A) A 200 ml waste water sample was analyzed for different parameters. Sample was firstly passed through non flammable filter- crucible assembly (weight: 25.439 g) and the assembly was dried (at 105 °C) to constant mass of 25.645 g. A 100 ml filtrate was placed in an evaporation dish assembly (weight: 275.419 g) and dried to 276.227g. Both crucible and evaporation dish assembly were placed in muffle furnace (at 550 °C) for an hour. Mass of crucible and evaporation dish assembly was measured to be 25.01 g and 275.944 g respectively. Determine dissolve solid, suspended solid, suspended volatile solid and dissolve volatile solid in mg/l. **(4)**

B) Calculate volume of equalization tank for given flow: **(4)**

Time	0-1	1-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9	9-10	10-11	11-12
Flow (m^3/s)	0.275	0.220	0.165	.0130	0.105	0.100	0.120	0.205	0.355	0.410	0.425	0.430
Time	12-1	1-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9	9-10	10-11	11-12
Flow (m^3/s)	0.425	0.405	0.385	0.350	0.325	0.325	0.330	0.365	0.400	0.400	0.380	0.345

Q.2 30000 m^3/d effluent is treated in rapid mixing tank and flocculator by mixing 35 mg/L alum dose. Design rapid mixing tank and flocculator for above. Data given: **(8)**

For rapid mixing tank:	For flocculator:
i. Detention time: 2 min ii. Velocity gradient: 900 s^{-1} iii. Tank geometry: square	i. 4 board- 4 paddle transverse unit ii. Depth: 4 m, width: 10 m maximum iii. Value of *Gt*: $3.5*10^4$ iv. Paddle velocity: 0.67 m/s

Viscosity: $1.003*10^{-3}$ Ns/m^2	Density: 999.1 kg/m^3	Drag coefficient: 1.8

Q.3 A) Compare Activated Sludge Process and Attached Growth System. **(4)**

B) Differentiate Aerobic treatment and Anaerobic Process for effluent treatment. **(4)**

Section-B

Q.4 A) What is lapse rate? How it affects plume behavior? Explain with diagram. **(4)**

B) Write about important elemental properties of atmosphere. **(4)**

Q.5 Coal based power plant is situated near a township having average building height of 20 m. Coal is burning at a rate of 5.0 ton/h as fuel contains 5.0% sulfur and 20.0% ash. Half of ash is emitted with flue gases at 150 °C and velocity of 35 m/s. Inner diameter of stack is 20 m. At the point of emission, temperature is 10 °C, pressure is 1000 millibars and wind velocity is 15 m/s. Find downwind ground level concentration at the distance of 1.5 km if crosswind dispersion coefficient is 210 m and for vertical is 160 m. **(8)**

Q.6 A) Find overall efficiency of cyclone if 7 μm particles are separated with 50% efficiency. Data given: **(4)**

Particle range (μm)	0-10	10-20	20-30	30-50	>50
Average size (μm)	5	15	25	40	60
% mass	18	32	24	16	10

B) Find if the wet scrubber is efficient enough to reduce SPM from 1100 kg/hr to 10 kg/hr in carrying gas. Data given: **(4)**

Particle size: 9μm
Particle density: 1900 kg/m^3
Gas viscosity: $2*10^{-4}$ g/cm.s
Gas kinematic viscosity: 0.2 cm^2/s
Gas density: 1.0 kg/m^3
Gas flow: 15 m^3/s
Gas velocity: 9000 cm/s
Gas temperature: 80 °C
Water temperature: 30 °C
Water density: 1000 kg/m^3
Water flow: 0.014 m^3/s
L/G ratio: 0.0009 l/ m^3
Penetration coefficient: 0.0056* characterizing parameter

Section-C

Q.7 A) Write about causes and control methods for automotive emission. **(4)**

B) Discuss combustion methods to reduce gaseous contaminants. **(4)**

Q.8 Analysis of solid waste is given below. Calculate overall moisture and density of sample. Also calculate energy on dry basis. Data given: **(8)**

Component	% Mass	% Moisture	Density (kg/m^3)	Energy (kJ/kg)
Food waste	15	70	290	4650
Paper	45	6	85	16750
Card board	10	5	50	16300
Plastic	10	2	65	32600
Garden waste	10	60	105	6500
Wood	5	20	240	18600
Tin can	5	3	90	700

Q.9 A) Determine volume of air required for complete oxidization of 1 ton solid waste having formula $C_{50}H_{100}O_{40}N$. **(4)**

B) Discuss methods for thermal and biological conversion methods for solid waste management. **(4)**

B.Tech. (C.E.) (V Sem.)

632 **Paper 5.5**

B.Tech. (C.E.) (FIFTH SEMESTER) EXAMINATION, DECEMBER 2016

PAPER 5.5— **Transport Phenomena**

TIME ALLOWED : THREE HOURS

Maximum Marks— 40

The question paper is divided into three Sections. Students are required to attempt five questions in all, selecting not more than two questions from each Section.

All questions carry equal marks.

All additional data required to solve questions are provided with the question paper only.

SECTION A

1. (a) Compute the steady state momentum flux z_{xy} in lbf/ft^2 when the lower plate velocity is 1 ft/sec in positive x direction, the plate separation y is 0·001 ft and the viscosity of fluid filled between parallel plates ψ is 0·7 cp (centipoise). 2

(b) Write the condition for geometrical and dynamic similarity in fluid flow for scaling (up or down). 2

Turn over

(c) Verify that "momentum per unit area per unit time" has the same dimensions as "force per unit area". 2

(d) Two immiscible liquids, A and B, are flowing in laminar flow between two parallel plates. Is it possible that the velocity profile would be of the following form as in figure 1? Explain. 2

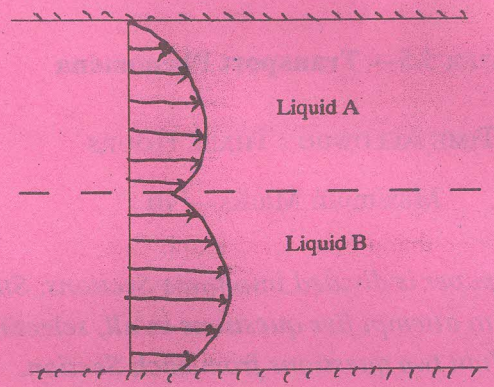

Fig. 1 : Velocity Profile

2. (a) Derive an expression of "velocity profile, average velocity, maximum velocity, film thickness and force on surface" of steady state laminar flow of fluid along an inclined flat plate surface. Assume viscosity and density of fluid to be constant. 5

(b) Water at 20°C is flowing down a vertical wall with Re=10 (Reynolds number). Calculate:— (i) volume flow rate in gallon per hour per foot of wall length and (ii) the film thickness in inches. Kinematic viscosity of water at 20°C is $1 \cdot 0037 \times 10^{-2}$ cm^2/sec, and 1 gallon = 3785·4 cm^3. 3

3. (a) Develop an expression for equation of motion in vectorial form by writing momentum balance over volume element in cartesian coordinates. 3

(b) The space between two coaxial cylinders is filled with an incompressible fluid at constant temperature. The radii of the inner and outer wetted surfaces are KR and R respectively. The angular velocity of rotation of the inner and outer cylinders are Ω_i and Ω_o. Determine distribution in the fluid and torque on the two cylinders needed to maintain the motion. (Use equation of motion.) 5

Section B

4. (a) Derive an expression for temperature distribution for the flow of an incompressible Newtonian fluid between two coaxial cylinders shown in figure 2. The surfaces of the inner and outer cylinders are maintained at temperature T_0 and T_b, respectively. Assume that T will be a function of radius alone and the inner cylinder is stationary and outer cylinder is rotating with angular velocity Ω. 4

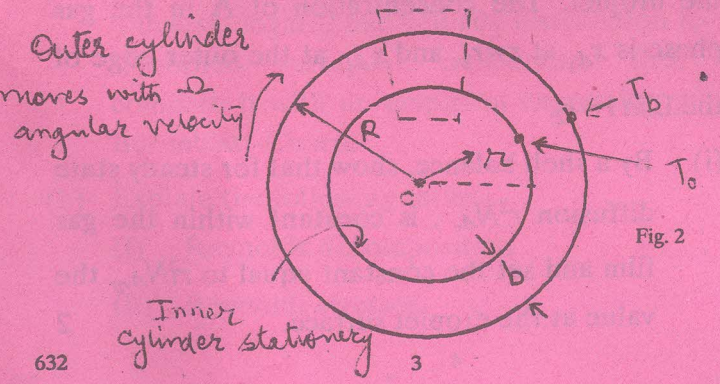

Fig. 2

(b) A copper wire has a radius 2 mm and a length of 5 m. For what voltage drop would the temperature rise at the wire axis be 10°C, if the surface temperature of the wire is 20°C? For copper, the Lorenz number is $\frac{k}{K_e T_o} = 2 \cdot 23 \times 10^{-8} \frac{\text{volt}^2}{(\text{Kelvin})^2}$ 4

5. (a) A solid material occupying the space from $y=0$ to $y=\infty$ (infinity) is initally at temperature T_0. At time $t=0$, the surface at $y=0$ is suddenly raised to temperature T_1 and maintained at that temperature for all time $t>0$. Find the time-dependent temperature profiles $T(y, t)$. 4

(b) Develop equations for the relationship of local pressure to density or temperature in a stream of ideal gas in which the momentum flux τ and heat flux q are neglibible. (Use equation of energy.) 4

6. (a) A droplet of liquid A, of radius r_1, is suspended in a stream of gas B. We postulate that there is a spherical stagnant gas film of radius r_2 surrounding the droplet. The concentration of A in the gas phase is x_{A_1} at $r=r_1$, and x_{A_2} at the outer edge of the film $r=r_2$.

(i) By a shell balance, show that for steady state diffusion $r^2 N_{A_r}$, is constant within the gas film and set the constant equal to $r_1^2 N_{A_{r_1}}$, the value at the droplet surface. 2

(ii) Show that the result in (i) leads to following equation for x_A :—

$$r_1^2 N_{A_{r_1}} = -\frac{cD_{AB}}{(1-x_A)} r^2 \frac{dx_A}{dr}$$ 2

(iii) Integrate the above equation between the limits r_1 to r_2 and determine the molar flux when $r_2 \to \infty$ 1

(b) Estimate the rate of absorption of CO_2 (component A) from a carbon dioxide bubble 0·5 cm in diameter rising through pure water (component B) at 18°C and at a pressure of 1 atom. The following data may be used:—

$D_{AB} = 1 \cdot 46 \times 10^{-5}$ cm²/sec

$C_{Ao} = 0 \cdot 041 \frac{\text{g-mole}}{\text{lit}}$

$V_t = 22$ cm/sec. 3

Section C

7. (a) Derive an expression for von-Karman Prandtl universal logarithmic velocity distribution for time smoothed turbulent momentum flux. Also compare it with an empirical expression given by Barenblatt-Chorin. 4

(b) Explain the following terms:—

(i) Reynolds decomposition

(ii) Reynolds stresses. 4

8. Use the Reynolds analogy $\left(r^{(t)}=d^{(t)}\right)$ to estimate the wall heat flux q_0 for the turbulent flow in a tube of diameter $D=2R$. Express the result in terms of temperature-difference driving force $T_0-\overline{T}_R$, where T_0 is the temperature at the wall $(y=0)$ and $\overline{T}_R$ is the time smoothed temperature at the tube axis $(y=R)$. 8

9. Write short notes on any *four*:—

(a) Eddy viscosity

(b) Eddy diffusivity

(c) Eddy thermal conductivity

(d) Prandtl mixing length theory

(e) Logarithmic turbulent temperature profile in inertial sublayer. 4×2

§B.6 EQUATION OF MOTION FOR A NEWTONIAN FLUID WITH CONSTANT ρ AND μ

$$[\rho Dv/Dt = -\nabla p + \mu\nabla^2 v + \rho g]$$

Cartesian coordinates (x, y, z):

$$\rho\left(\frac{\partial v_x}{\partial t} + v_x\frac{\partial v_x}{\partial x} + v_y\frac{\partial v_x}{\partial y} + v_z\frac{\partial v_x}{\partial z}\right) = -\frac{\partial p}{\partial x} + \mu\left[\frac{\partial^2 v_x}{\partial x^2} + \frac{\partial^2 v_x}{\partial y^2} + \frac{\partial^2 v_x}{\partial z^2}\right] + \rho g_x \tag{B.6-1}$$

$$\rho\left(\frac{\partial v_y}{\partial t} + v_x\frac{\partial v_y}{\partial x} + v_y\frac{\partial v_y}{\partial y} + v_z\frac{\partial v_y}{\partial z}\right) = -\frac{\partial p}{\partial y} + \mu\left[\frac{\partial^2 v_y}{\partial x^2} + \frac{\partial^2 v_y}{\partial y^2} + \frac{\partial^2 v_y}{\partial z^2}\right] + \rho g_y \tag{B.6-2}$$

$$\rho\left(\frac{\partial v_z}{\partial t} + v_x\frac{\partial v_z}{\partial x} + v_y\frac{\partial v_z}{\partial y} + v_z\frac{\partial v_z}{\partial z}\right) = -\frac{\partial p}{\partial z} + \mu\left[\frac{\partial^2 v_z}{\partial x^2} + \frac{\partial^2 v_z}{\partial y^2} + \frac{\partial^2 v_z}{\partial z^2}\right] + \rho g_z \tag{B.6-3}$$

Cylindrical coordinates (r, θ, z):

$$\rho\left(\frac{\partial v_r}{\partial t} + v_r\frac{\partial v_r}{\partial r} + \frac{v_\theta}{r}\frac{\partial v_r}{\partial \theta} + v_z\frac{\partial v_r}{\partial z} - \frac{v_\theta^2}{r}\right) = -\frac{\partial p}{\partial r} + \mu\left[\frac{\partial}{\partial r}\left(\frac{1}{r}\frac{\partial}{\partial r}(rv_r)\right) + \frac{1}{r^2}\frac{\partial^2 v_r}{\partial \theta^2} + \frac{\partial^2 v_r}{\partial z^2} - \frac{2}{r^2}\frac{\partial v_\theta}{\partial \theta}\right] + \rho g_r \tag{B.6-4}$$

$$\rho\left(\frac{\partial v_\theta}{\partial t} + v_r\frac{\partial v_\theta}{\partial r} + \frac{v_\theta}{r}\frac{\partial v_\theta}{\partial \theta} + v_z\frac{\partial v_\theta}{\partial z} + \frac{v_r v_\theta}{r}\right) = -\frac{1}{r}\frac{\partial p}{\partial \theta} + \mu\left[\frac{\partial}{\partial r}\left(\frac{1}{r}\frac{\partial}{\partial r}(rv_\theta)\right) + \frac{1}{r^2}\frac{\partial^2 v_\theta}{\partial \theta^2} + \frac{\partial^2 v_\theta}{\partial z^2} + \frac{2}{r^2}\frac{\partial v_r}{\partial \theta}\right] + \rho g_\theta \tag{B.6-5}$$

$$\rho\left(\frac{\partial v_z}{\partial t} + v_r\frac{\partial v_z}{\partial r} + \frac{v_\theta}{r}\frac{\partial v_z}{\partial \theta} + v_z\frac{\partial v_z}{\partial z}\right) = -\frac{\partial p}{\partial z} + \mu\left[\frac{1}{r}\frac{\partial}{\partial r}\left(r\frac{\partial v_z}{\partial r}\right) + \frac{1}{r^2}\frac{\partial^2 v_z}{\partial \theta^2} + \frac{\partial^2 v_z}{\partial z^2}\right] + \rho g_z \tag{B.6-6}$$

Spherical coordinates (r, θ, φ):

$$\rho\left(\frac{\partial v_r}{\partial t} + v_r\frac{\partial v_r}{\partial r} + \frac{v_\theta}{r}\frac{\partial v_r}{\partial \theta} + \frac{v_\phi}{r\sin\theta}\frac{\partial v_r}{\partial \phi} - \frac{v_\theta^2 + v_\phi^2}{r}\right) = -\frac{\partial p}{\partial r} + \mu\left[\frac{1}{r^2}\frac{\partial}{\partial r}(r^2 v_r) + \frac{1}{r^2\sin\theta}\frac{\partial}{\partial \theta}\left(\sin\theta\frac{\partial v_r}{\partial \theta}\right) + \frac{1}{r^2\sin^2\theta}\frac{\partial^2 v_r}{\partial \phi^2}\right] + \rho g_r \tag{B.6-7}*$$

$$\rho\left(\frac{\partial v_\theta}{\partial t} + v_r\frac{\partial v_\theta}{\partial r} + \frac{v_\theta}{r}\frac{\partial v_\theta}{\partial \theta} + \frac{v_\phi}{r\sin\theta}\frac{\partial v_\theta}{\partial \phi} + \frac{v_r v_\theta - v_\phi^2\cot\theta}{r}\right) = -\frac{1}{r}\frac{\partial p}{\partial \theta} + \mu\left[\frac{1}{r^2}\frac{\partial}{\partial r}\left(r^2\frac{\partial v_\theta}{\partial r}\right) + \frac{1}{r^2}\frac{\partial}{\partial \theta}\left(\frac{1}{\sin\theta}\frac{\partial}{\partial \theta}(v_\theta\sin\theta)\right) + \frac{1}{r^2\sin^2\theta}\frac{\partial^2 v_\theta}{\partial \phi^2} + \frac{2}{r^2}\frac{\partial v_r}{\partial \theta} - \frac{2\cot\theta}{r^2\sin\theta}\frac{\partial v_\phi}{\partial \phi}\right] + \rho g_\theta \tag{B.6-8}$$

$$\rho\left(\frac{\partial v_\phi}{\partial t} + v_r\frac{\partial v_\phi}{\partial r} + \frac{v_\theta}{r}\frac{\partial v_\phi}{\partial \theta} + \frac{v_\phi}{r\sin\theta}\frac{\partial v_\phi}{\partial \phi} + \frac{v_\phi v_r + v_\theta v_\phi\cot\theta}{r}\right) = -\frac{1}{r\sin\theta}\frac{\partial p}{\partial \phi} + \mu\left[\frac{1}{r^2}\frac{\partial}{\partial r}\left(r^2\frac{\partial v_\phi}{\partial r}\right) + \frac{1}{r^2}\frac{\partial}{\partial \theta}\left(\frac{1}{\sin\theta}\frac{\partial}{\partial \theta}(v_\phi\sin\theta)\right) + \frac{1}{r^2\sin^2\theta}\frac{\partial^2 v_\phi}{\partial \phi^2} + \frac{2}{r^2\sin\theta}\frac{\partial v_r}{\partial \phi} + \frac{2\cot\theta}{r^2\sin\theta}\frac{\partial v_\theta}{\partial \phi}\right] + \rho g_\phi \tag{B.6-9}$$

* The quantity in the brackets in Eq. B.6-7 is not what one would expect from Eq. (M) for $[\nabla\cdot\nabla v]$ in Table A.7-3, because we have added to Eq. (M) the expression for $(2/3)(\nabla\cdot v)$, which is zero for fluids with constant ρ. This gives a much simpler equation.

§B.7 THE DISSIPATION FUNCTION Φ_v FOR NEWTONIAN FLUIDS (SEE EQ. 3.3-3)

Cartesian coordinates (x, y, z):

$$\Phi_v = 2\left[\left(\frac{\partial v_x}{\partial x}\right)^2 + \left(\frac{\partial v_y}{\partial y}\right)^2 + \left(\frac{\partial v_z}{\partial z}\right)^2\right] + \left[\frac{\partial v_y}{\partial x} + \frac{\partial v_x}{\partial y}\right]^2 + \left[\frac{\partial v_z}{\partial y} + \frac{\partial v_y}{\partial z}\right]^2 + \left[\frac{\partial v_x}{\partial z} + \frac{\partial v_z}{\partial x}\right]^2 - \frac{2}{3}\left[\frac{\partial v_x}{\partial x} + \frac{\partial v_y}{\partial y} + \frac{\partial v_z}{\partial z}\right]^2 \tag{B.7-1}$$

Cylindrical coordinates (r, θ, z):

$$\Phi_v = 2\left[\left(\frac{\partial v_r}{\partial r}\right)^2 + \left(\frac{1}{r}\frac{\partial v_\theta}{\partial \theta} + \frac{v_r}{r}\right)^2 + \left(\frac{\partial v_z}{\partial z}\right)^2\right] + \left[r\frac{\partial}{\partial r}\left(\frac{v_\theta}{r}\right) + \frac{1}{r}\frac{\partial v_r}{\partial \theta}\right]^2 + \left[\frac{1}{r}\frac{\partial v_z}{\partial \theta} + \frac{\partial v_\theta}{\partial z}\right]^2 + \left[\frac{\partial v_r}{\partial z} + \frac{\partial v_z}{\partial r}\right]^2 - \frac{2}{3}\left[\frac{1}{r}\frac{\partial}{\partial r}(rv_r) + \frac{1}{r}\frac{\partial v_\theta}{\partial \theta} + \frac{\partial v_z}{\partial z}\right]^2 \tag{B.7-2}$$

Spherical coordinates (r, θ, φ):

$$\Phi_v = 2\left[\left(\frac{\partial v_r}{\partial r}\right)^2 + \left(\frac{1}{r}\frac{\partial v_\theta}{\partial \theta} + \frac{v_r}{r}\right)^2 + \left(\frac{1}{r\sin\theta}\frac{\partial v_\phi}{\partial \phi} + \frac{v_r + v_\theta\cot\theta}{r}\right)^2\right] + \left[r\frac{\partial}{\partial r}\left(\frac{v_\theta}{r}\right) + \frac{1}{r}\frac{\partial v_r}{\partial \theta}\right]^2 + \left[\frac{\sin\theta}{r}\frac{\partial}{\partial \theta}\left(\frac{v_\phi}{\sin\theta}\right) + \frac{1}{r\sin\theta}\frac{\partial v_\theta}{\partial \phi}\right]^2 + \left[\frac{1}{r\sin\theta}\frac{\partial v_r}{\partial \phi} + r\frac{\partial}{\partial r}\left(\frac{v_\phi}{r}\right)\right]^2 - \frac{2}{3}\left[\frac{1}{r^2}\frac{\partial}{\partial r}(r^2 v_r) + \frac{1}{r\sin\theta}\frac{\partial}{\partial \theta}(v_\theta\sin\theta) + \frac{1}{r\sin\theta}\frac{\partial v_\phi}{\partial \phi}\right]^2 \tag{B.7-3}$$

§B.8 THE EQUATION OF ENERGY IN TERMS OF q

$$[\rho\hat{C}_p DT/Dt = -(\nabla\cdot q) - (\partial\ln\rho/\partial\ln T)_p Dp/Dt - (\tau:\nabla v)]$$

Cartesian coordinates (x, y, z):

$$\rho\hat{C}_p\left(\frac{\partial T}{\partial t} + v_x\frac{\partial T}{\partial x} + v_y\frac{\partial T}{\partial y} + v_z\frac{\partial T}{\partial z}\right) = -\left[\frac{\partial q_x}{\partial x} + \frac{\partial q_y}{\partial y} + \frac{\partial q_z}{\partial z}\right] - \left(\frac{\partial\ln\rho}{\partial\ln T}\right)_p\frac{Dp}{Dt} - (\tau:\nabla v) \tag{B.8-1}*$$

Cylindrical coordinates (r, θ, z):

$$\rho\hat{C}_p\left(\frac{\partial T}{\partial t} + v_r\frac{\partial T}{\partial r} + \frac{v_\theta}{r}\frac{\partial T}{\partial \theta} + v_z\frac{\partial T}{\partial z}\right) = -\left[\frac{1}{r}\frac{\partial}{\partial r}(rq_r) + \frac{1}{r}\frac{\partial q_\theta}{\partial \theta} + \frac{\partial q_z}{\partial z}\right] - \left(\frac{\partial\ln\rho}{\partial\ln T}\right)_p\frac{Dp}{Dt} - (\tau:\nabla v) \tag{B.8-2}*$$

Spherical coordinates (r, θ, φ):

$$\rho\hat{C}_p\left(\frac{\partial T}{\partial t} + v_r\frac{\partial T}{\partial r} + \frac{v_\theta}{r}\frac{\partial T}{\partial \theta} + \frac{v_\phi}{r\sin\theta}\frac{\partial T}{\partial \phi}\right) = -\left[\frac{1}{r^2}\frac{\partial}{\partial r}(r^2 q_r) + \frac{1}{r\sin\theta}\frac{\partial}{\partial \theta}(q_\theta\sin\theta) + \frac{1}{r\sin\theta}\frac{\partial q_\phi}{\partial \phi}\right] - \left(\frac{\partial\ln\rho}{\partial\ln T}\right)_p\frac{Dp}{Dt} - (\tau:\nabla v) \tag{B.8-3}*$$

* The viscous dissipation term, $-(\tau:\nabla v)$, is given in Appendix A, Tables A.7-1, 2, 3. This term may usually be neglected, except for systems with very large velocity gradients. The term containing $(\partial\ln\rho/\partial\ln T)_p$ is zero for fluid with constant ρ.

FICK'S (FIRST) LAW OF BINARY DIFFUSION[a]

$$[j_A = -\rho\mathscr{D}_{AB}\nabla\omega_A]$$

Cartesian coordinates (x, y, z):

$$j_{Ax} = -\rho\mathscr{D}_{AB}\frac{\partial\omega_A}{\partial x} \quad \text{(B.3-1)}$$

$$j_{Ay} = -\rho\mathscr{D}_{AB}\frac{\partial\omega_A}{\partial y} \quad \text{(B.3-2)}$$

$$j_{Az} = -\rho\mathscr{D}_{AB}\frac{\partial\omega_A}{\partial z} \quad \text{(B.3-3)}$$

Cylindrical coordinates (r, θ, z):

$$j_{Ar} = -\rho\mathscr{D}_{AB}\frac{\partial\omega_A}{\partial r} \quad \text{(B.3-4)}$$

$$j_{A\theta} = -\rho\mathscr{D}_{AB}\frac{1}{r}\frac{\partial\omega_A}{\partial\theta} \quad \text{(B.3-5)}$$

$$j_{Az} = -\rho\mathscr{D}_{AB}\frac{\partial\omega_A}{\partial z} \quad \text{(B.3-6)}$$

Spherical coordinates (r, θ, φ):

$$j_{Ar} = -\rho\mathscr{D}_{AB}\frac{\partial\omega_A}{\partial r} \quad \text{(B.3-7)}$$

$$j_{A\theta} = -\rho\mathscr{D}_{AB}\frac{1}{r}\frac{\partial\omega_A}{\partial\theta} \quad \text{(B.3-8)}$$

$$j_{A\phi} = -\rho\mathscr{D}_{AB}\frac{1}{r\sin\theta}\frac{\partial\omega_A}{\partial\phi} \quad \text{(B.3-9)}$$

[a] To get the molar fluxes with respect to the molar average velocity, replace j_A, ρ, and ω_A by J^*_A, c, and x_A.

THE EQUATION OF CONTINUITY[a]

$$[\partial\rho/\partial t + (\nabla\cdot\rho v) = 0]$$

Cartesian coordinates (x, y, z):

$$\frac{\partial\rho}{\partial t} + \frac{\partial}{\partial x}(\rho v_x) + \frac{\partial}{\partial y}(\rho v_y) + \frac{\partial}{\partial z}(\rho v_z) = 0 \quad \text{(B.4-1)}$$

Cylindrical coordinates (r, θ, z):

$$\frac{\partial\rho}{\partial t} + \frac{1}{r}\frac{\partial}{\partial r}(\rho r v_r) + \frac{1}{r}\frac{\partial}{\partial\theta}(\rho v_\theta) + \frac{\partial}{\partial z}(\rho v_z) = 0 \quad \text{(B.4-2)}$$

Spherical coordinates (r, θ, φ):

$$\frac{\partial\rho}{\partial t} + \frac{1}{r^2}\frac{\partial}{\partial r}(\rho r^2 v_r) + \frac{1}{r\sin\theta}\frac{\partial}{\partial\theta}(\rho v_\theta\sin\theta) + \frac{1}{r\sin\theta}\frac{\partial}{\partial\phi}(\rho v_\phi) = 0 \quad \text{(B.4-3)}$$

[a] When the fluid is assumed to have constant mass density ρ, the equation simplifies to $(\nabla\cdot v) = 0$.

§B.5 THE EQUATION OF MOTION IN TERMS OF τ

$$[\rho Dv/Dt = -\nabla p - [\nabla\cdot\tau] + \rho g]$$

Cartesian coordinates (x, y, z):[a]

$$\rho\left(\frac{\partial v_x}{\partial t} + v_x\frac{\partial v_x}{\partial x} + v_y\frac{\partial v_x}{\partial y} + v_z\frac{\partial v_x}{\partial z}\right) = -\frac{\partial p}{\partial x} - \left[\frac{\partial}{\partial x}\tau_{xx} + \frac{\partial}{\partial y}\tau_{yx} + \frac{\partial}{\partial z}\tau_{zx}\right] + \rho g_x \quad \text{(B.5-1)}$$

$$\rho\left(\frac{\partial v_y}{\partial t} + v_x\frac{\partial v_y}{\partial x} + v_y\frac{\partial v_y}{\partial y} + v_z\frac{\partial v_y}{\partial z}\right) = -\frac{\partial p}{\partial y} - \left[\frac{\partial}{\partial x}\tau_{xy} + \frac{\partial}{\partial y}\tau_{yy} + \frac{\partial}{\partial z}\tau_{zy}\right] + \rho g_y \quad \text{(B.5-2)}$$

$$\rho\left(\frac{\partial v_z}{\partial t} + v_x\frac{\partial v_z}{\partial x} + v_y\frac{\partial v_z}{\partial y} + v_z\frac{\partial v_z}{\partial z}\right) = -\frac{\partial p}{\partial z} - \left[\frac{\partial}{\partial x}\tau_{xz} + \frac{\partial}{\partial y}\tau_{yz} + \frac{\partial}{\partial z}\tau_{zz}\right] + \rho g_z \quad \text{(B.5-3)}$$

[a] These equations have been written without making the assumption that τ is symmetric. This means, for example, that when the usual assumption is made that the stress tensor is symmetric, τ_{xy} and τ_{yx} may be interchanged.

Cylindrical coordinates (r, θ, z):[b]

$$\rho\left(\frac{\partial v_r}{\partial t} + v_r\frac{\partial v_r}{\partial r} + \frac{v_\theta}{r}\frac{\partial v_r}{\partial\theta} + v_z\frac{\partial v_r}{\partial z} - \frac{v_\theta^2}{r}\right) = -\frac{\partial p}{\partial r} - \left[\frac{1}{r}\frac{\partial}{\partial r}(r\tau_{rr}) + \frac{1}{r}\frac{\partial}{\partial\theta}\tau_{\theta r} + \frac{\partial}{\partial z}\tau_{zr} - \frac{\tau_{\theta\theta}}{r}\right] + \rho g_r \quad \text{(B.5-4)}$$

$$\rho\left(\frac{\partial v_\theta}{\partial t} + v_r\frac{\partial v_\theta}{\partial r} + \frac{v_\theta}{r}\frac{\partial v_\theta}{\partial\theta} + v_z\frac{\partial v_\theta}{\partial z} + \frac{v_r v_\theta}{r}\right) = -\frac{1}{r}\frac{\partial p}{\partial\theta} - \left[\frac{1}{r^2}\frac{\partial}{\partial r}(r^2\tau_{r\theta}) + \frac{1}{r}\frac{\partial}{\partial\theta}\tau_{\theta\theta} + \frac{\partial}{\partial z}\tau_{z\theta} + \frac{\tau_{\theta r} - \tau_{r\theta}}{r}\right] + \rho g_\theta \quad \text{(B.5-5)}$$

$$\rho\left(\frac{\partial v_z}{\partial t} + v_r\frac{\partial v_z}{\partial r} + \frac{v_\theta}{r}\frac{\partial v_z}{\partial\theta} + v_z\frac{\partial v_z}{\partial z}\right) = -\frac{\partial p}{\partial z} - \left[\frac{1}{r}\frac{\partial}{\partial r}(r\tau_{rz}) + \frac{1}{r}\frac{\partial}{\partial\theta}\tau_{\theta z} + \frac{\partial}{\partial z}\tau_{zz}\right] + \rho g_z \quad \text{(B.5-6)}$$

[b] These equations have been written without making the assumption that τ is symmetric. This means, for example, that when the usual assumption is made that the stress tensor is symmetric, $\tau_{r\theta} - \tau_{\theta r} = 0$.

Spherical coordinates (r, θ, φ):[c]

$$\rho\left(\frac{\partial v_r}{\partial t} + v_r\frac{\partial v_r}{\partial r} + \frac{v_\theta}{r}\frac{\partial v_r}{\partial\theta} + \frac{v_\phi}{r\sin\theta}\frac{\partial v_r}{\partial\phi} - \frac{v_\theta^2 + v_\phi^2}{r}\right) = -\frac{\partial p}{\partial r}$$
$$- \left[\frac{1}{r^2}\frac{\partial}{\partial r}(r^2\tau_{rr}) + \frac{1}{r\sin\theta}\frac{\partial}{\partial\theta}(\tau_{\theta r}\sin\theta) + \frac{1}{r\sin\theta}\frac{\partial}{\partial\phi}\tau_{\phi r} - \frac{\tau_{\theta\theta} + \tau_{\phi\phi}}{r}\right] + \rho g_r \quad \text{(B.5-7)}$$

$$\rho\left(\frac{\partial v_\theta}{\partial t} + v_r\frac{\partial v_\theta}{\partial r} + \frac{v_\theta}{r}\frac{\partial v_\theta}{\partial\theta} + \frac{v_\phi}{r\sin\theta}\frac{\partial v_\theta}{\partial\phi} + \frac{v_r v_\theta - v_\phi^2\cot\theta}{r}\right) = -\frac{1}{r}\frac{\partial p}{\partial\theta}$$
$$- \left[\frac{1}{r^2}\frac{\partial}{\partial r}(r^2\tau_{r\theta}) + \frac{1}{r\sin\theta}\frac{\partial}{\partial\theta}(\tau_{\theta\theta}\sin\theta) + \frac{1}{r\sin\theta}\frac{\partial}{\partial\phi}\tau_{\phi\theta} + \frac{(\tau_{\theta r} - \tau_{r\theta}) - \tau_{\phi\phi}\cot\theta}{r}\right] + \rho g_\theta \quad \text{(B.5-8)}$$

$$\rho\left(\frac{\partial v_\phi}{\partial t} + v_r\frac{\partial v_\phi}{\partial r} + \frac{v_\theta}{r}\frac{\partial v_\phi}{\partial\theta} + \frac{v_\phi}{r\sin\theta}\frac{\partial v_\phi}{\partial\phi} + \frac{v_\phi v_r + v_\theta v_\phi\cot\theta}{r}\right) = -\frac{1}{r\sin\theta}\frac{\partial p}{\partial\phi}$$
$$- \left[\frac{1}{r^2}\frac{\partial}{\partial r}(r^2\tau_{r\phi}) + \frac{1}{r\sin\theta}\frac{\partial}{\partial\theta}(\tau_{\theta\phi}\sin\theta) + \frac{1}{r\sin\theta}\frac{\partial}{\partial\phi}\tau_{\phi\phi} + \frac{(\tau_{\phi r} - \tau_{r\phi}) + \tau_{\theta\phi}\cot\theta}{r}\right] + \rho g_\phi \quad \text{(B.5-9)}$$

[c] These equations have been written without making the assumption that τ is symmetric. This means, for example, that when the usual assumption is made that the stress tensor is symmetric, $\tau_{r\theta} - \tau_{\theta r} = 0$.