2014-15
B.TECH. (WINTER SEMESTER) EXAMINATION
(MECH. / ARCH. / CIVIL. / CHEMICAL / PETROCHEMICAL / ELECTRICAL /
ELECTRONICS / COMPUTER ENGINEERING)
(OPEN ELECTIVE)
SOLID WASTE MANAGEMENT
(CH-337)

Maximum Marks: 60 Credits: 04 Duration: Three Hours

Answer the questions in the order stated in the question paper.
Assume suitable data if missing.
Notations used have their usual meaning.

Q.No. Question M.M.
1(a) Discuss the three Rs principle for solid waste management. [07]

OR

1(a') Discuss the functional elements of a solid waste management system [07]

1(b) For a weekly waste production data from an industrial account for a calendar quarter of operation shown in Table I, determine the statistical characteristics and explain its physical significance. [08]

Table I: Weekly Waste Production Data

<table>
<thead>
<tr>
<th>Week No.</th>
<th>Waste (m³/wk)</th>
<th>Week No.</th>
<th>Waste (m³/wk)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>22</td>
<td>8</td>
<td>28</td>
</tr>
<tr>
<td>2</td>
<td>23</td>
<td>9</td>
<td>29</td>
</tr>
<tr>
<td>3</td>
<td>27</td>
<td>10</td>
<td>27</td>
</tr>
<tr>
<td>4</td>
<td>26</td>
<td>11</td>
<td>25</td>
</tr>
<tr>
<td>5</td>
<td>29</td>
<td>12</td>
<td>24</td>
</tr>
<tr>
<td>6</td>
<td>31</td>
<td>13</td>
<td>23</td>
</tr>
<tr>
<td>7</td>
<td>30</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
2(a) What is a Hauled Collection System (HCS)? Discuss along with their types and personnel requirements.

(OR)

2(a') Explain the following terms with reference to waste collection operation.

(i) Pickup
(ii) Haul
(iii) At Site
(iv) Off Route

2(b) The following average speeds (Table II) were obtained for various round trip distances to a disposal site. Find the haul speed constants, a and b, and the round trip haul time for a site that is located 18 km away.

Table II: Round Trip Distance and Average Haul Speed

<table>
<thead>
<tr>
<th>Round Trip Distance (x), km/trip</th>
<th>Average Haul Speed, km/h</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>27</td>
</tr>
<tr>
<td>5</td>
<td>30</td>
</tr>
<tr>
<td>8</td>
<td>52</td>
</tr>
<tr>
<td>12</td>
<td>58</td>
</tr>
<tr>
<td>16</td>
<td>65</td>
</tr>
<tr>
<td>20</td>
<td>68</td>
</tr>
<tr>
<td>25</td>
<td>73</td>
</tr>
</tbody>
</table>

3(a) Explain and illustrate various gas generation phases in an active landfill.

(OR)

3(a') Explain the Water Balance Method for estimation of the quantity of landfill leachate. For an organic waste represented by $C_{620}H_{1555}O_{710}N_7S$, determine water consumed in the formation of landfill gas.
3(b) A colony having a population of 7000 generates solid wastes at the rate of 1.2 kg/capita/day. The compacted specific weight of solid wastes in landfill is 650 kg/m³ and the average depth of compacted solid wastes in landfill is 5m. Determine the required landfill area including buffer zone for 20 years of operation.

4(a) Draw a neat sketch of Flash Pyrolysis system and discuss its working along with the products obtained.

(OR)

4(a') Discuss the design and operational considerations for the aerobic composting system.

4(c) Determine the amount of oxygen required to oxidize 9000 kg of an organic solid waste aerobically. Assume that the initial composition of the organic material to be decomposed is given by \([C_6H_7O_2(OH)_3]_5\), that the final composition of the residual organic matter is estimated to be \([C_6H_7O_2(OH)_3]_3\), and that 400 kg of material remains after the oxidation process.
Q.No. | Question | M.M.
--- | --- | ---
1(a) | Explain the principle of operation of IGBT and enumerate its advantages and disadvantages as compared to an SCR. | [6]
(b) | What is the difference between power diode and signal diode? What are the different methods to turn on the thyristor? | [6]
2(a) | What are different kinds of converters? State the application of power electronics. | [6]
(b) | What do you understand by a latching device? What method is used to reduce the reverse recovery time for a power semiconductor diode? | [6]

OR

2'(a) | Explain with the help of waveforms, the working of a RC full wave triggering circuit for low and high value of R. | [6]
(b) | What is a Snubber circuit? What losses occur in a thyristor during working conditions? Define hard-driving or over-driving. | [6]
3(a) | Find the THD of the line current of a single-phase full-wave converter with a continuous load current at \( \alpha = 130^\circ \). | [6]
(b) | Draw and explain the wave shapes of supply voltage, output voltage, load current, current through SCR, current through freewheeling diode and voltage drop across SCR of a single phase full wave controlled rectifier feeding an RLE load. | [6]

OR

3'(a) | Draw the circuit diagram and explain the working principle of a single phase dual converter. | [6]
(b) With the help of waveforms, explain the working of a three-phase full-converter with an RL load. Take switching angle $\alpha = 90^\circ$.

4(a) What are the advantages and disadvantages of a Buck-Boost and Cuk regulator? [6]

(b) Write a short note on (i) SMPS and (ii) UPS [6]

OR

(b') What is the principle of zero-current-switching (ZVS) resonant converters? What are the advantages and limitations of ZVS converters? [6]

5(a) Why cyclo-converters are used? Compare it with an ac regulator. [6]

(b) What is meant a series inverter? What are the applications of a series inverter? What is the condition to be satisfied in the selection of L and C in a series inverter? [6]

OR

(b') Describe single phase full bridge inverter with relevant voltage and current waveforms. Enumerate the simplifying assumptions made if any. [6]
Q. No. 1(a) Solve the following system of equations

\[2x_1 + x_2 + x_3 + 2x_4 = 2;\quad 4x_1 + 2x_3 + x_4 = 3;\quad 3x_1 + 2x_2 + 2x_3 = -1;\]
\[x_3 + 3x_2 + 2x_3 = -4.\]

by using Gauss elimination method with partial pivoting.

OR

1'(a) Use Doolittle's LU factorization method, to solve the following system of equations:

\[2x + y + 4z = 12,\quad 8x - 3y + 2z = 20,\quad 4x + 11y - z = 33.\]

1(b) Compute singular value decomposition (SVD) of the matrix

\[
\begin{bmatrix}
2 & 4 \\
1 & 3 \\
0 & 0 \\
0 & 0 \\
\end{bmatrix}
\]

1(c) Transform the matrix

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

to tridiagonal form by Given's method and find the eigenvector corresponding to the largest eigenvalue from the eigenvectors of the tridiagonal matrix.

2(a) Denoting the interpolant of \(f(x)\) on the set of distinct points \(x_0, x_1, x_2, \ldots, x_n\) by

\[\sum_{k=0}^{n} l_k(x)f(x_k),\]

find an expression for \(\sum_{k=0}^{n} l_k(0)x_k^{n+1}\).

OR

2'(a) Obtain the formula to determine step size \(h\) that can be used in the tabulation of a function \(f(x), a \leq x \leq b\) at equally spaced nodal points so that the truncation error of the quadratic interpolation is less than \(\varepsilon\). Hence find \(h\) if \(f(x) = x^2 e^x\), \([a, b] = [0, 1]\) and \(\varepsilon = 5 \times 10^{-6}\).
2(b) (i) Find whether the function defined by
\[ f(x) = \begin{cases} 
-x^2 - 2x^3, & -1 \leq x \leq 0 \\
-x^2 + 2x^3, & 0 \leq x \leq 1 
\end{cases} \]
is a cubic spline on \([-1,1]\) or not.

(ii) Obtain a cubic spline \( R \) for the data

<table>
<thead>
<tr>
<th>( x )</th>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
</tr>
</thead>
<tbody>
<tr>
<td>( f(x) )</td>
<td>1</td>
<td>4</td>
<td>10</td>
<td>8</td>
</tr>
</tbody>
</table>

Under the conditions \( M(0) = 0 = M(3) \) and valid in the interval \([1, 2]\).

Hence obtain the estimate of \( f(1.5) \).

2(c) Calculate the rational approximation \( R_{2,3}(x) \) for the function \( \tan^{-1}x \). Also write the order of its approximation.

3(a) For the function \( f(x) = 1 + \sin 2x \) on the interval \([0, \pi]\), determine \( L_1 \), \( L_2 \) and \( L_\infty \) norms with respect to weight function \( w(x) = x \).

3(b) A person runs the same track for five consecutive days and is timed as follows:

<table>
<thead>
<tr>
<th>Days(x)</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time(y)</td>
<td>15.30</td>
<td>15.10</td>
<td>15.00</td>
<td>14.50</td>
<td>14.00</td>
</tr>
</tbody>
</table>

Make a least square fit to the above data using the function \( a + \frac{b}{x} + \frac{c}{x^2} \).

OR

3'(b) A function is approximated by a piecewise linear function in the sense that

\[ \int_0^1 [f(x) - \sum_{l=0}^{10} a_l \varphi_l(x)]^2 \, dx \]
is minimized, where the shape functions \( \varphi_l \) are defined by

\[ \varphi_3 = \begin{cases} 
1 - 10x, & 0 \leq x \leq 0.1 \\
0, & \text{otherwise,}
\end{cases} \]

\[ \varphi_{10} = \begin{cases} 
10x - 9, & 0.9 \leq x \leq 1 \\
0, & \text{otherwise,}
\end{cases} \]

\[ \varphi_l = \begin{cases} 
10(x - x_{l-1}), & x_{l-1} \leq x \leq x_l \\
10(x_{l+1} - x), & x_l \leq x \leq x_{l+1} \\
0, & \text{otherwise}, \quad x_l = 0.1l, l = 1(1)9
\end{cases} \]

Write down the coefficient matrix of normal equations.

3(c) Obtain the Chebyshev linear polynomial approximation of the type \( ax + b \) to the function \( f(x) = \frac{1}{x^2} \) on the interval \([1,2]\).
4(a) A calculator company produces scientific and graphing calculators. Long-term projections indicate an expected demand of at least 100 scientific and 80 graphing calculators each day. Because of limitations on production capacity, no more than 200 scientific and 170 graphing calculators can be made daily. To satisfy a shipping contract, a total of at least 200 calculators may be shipped each day. If each scientific calculator sold results in a $2 loss, but each graphing calculator produces a $5 profit, use graphical method to determine, how many of each type should be made daily to maximize net profit.

4(b) Use simplex method, to solve the following LPP:
Maximize  \( Z = 2x_1 + x_2 - 3x_3 + 5x_4 \)
Subject to  \( x_1 + 2x_2 - 2x_3 + 4x_4 \leq 40; \)  \( 2x_1 - x_2 + x_3 + 2x_4 \leq 8; \)
\( 4x_1 - 2x_2 + x_3 - x_4 \leq 10; \)  \( x_1, x_2, x_3, x_4 \geq 0. \)

OR

4’(b) Use simplex method, to solve the following LPP:
Minimize  \( Z = 4x + y \)
Subject to  \( 3x + y = 3; \)  \( 4x + 3y \geq 6; \)  \( x + 2y \leq 4; \)  \( x, y \geq 0. \)
2014-2015
B.TECH (AUTUMN SEMESTER) EXAMINATION
(ELECT./MECH./CHEM./ELECTRONICS// COMPUTER/ ARCHITECTURE/ PETRO
CHEM. ENGG.)
ATMOSPHERIC CHEMISTRY
(AC-308)

Maximum Marks: 60
Credits: 04
Duration: Three Hours

Answer all the questions.

Q.No.  

1 Attempt any two of the following:
(a) What is insolation? Discuss the energy balance in the atmosphere.
(b) Explain with the help of chemical equations sequence of NO-NO$_2$-O$_3$
    photochemical reaction.
(c) Explain the impacts of increased exposure of UV by action spectrum.

2(a) Name the criteria pollutants. Differentiate between primary and secondary
    pollutants with examples.
(b) Describe the physical, chemical and biological characteristics of particulate matter.

3(a) Name the methods used to control air pollutants. What is source correction method?
(b) Discuss the principle and working of Venturi scrubber.

4(a) Describe the condensation method for collecting gaseous pollutants.
(b) Describe any two of the following:
    (i) Hapcofite method for the determination of carbon monoxide.
    (ii) Saltzman’s method for the determination of NO$_x$
    (iii) Ethylene method for the determination of H$_2$S

5 Why greenhouse effect is called ‘global warming’? How the greenhouse effect is
    produced? Explain the incoming extra-terrestrial solar radiations and outgoing
    radiations from earth’s surface with the help of intensity verses wavelength diagram.

6 Write notes on any two of the following
(a) Absorption of electromagnetic radiation by a molecule
(b) Role of cathode lamp in atomic absorption spectrometry
(c) Nitrogen cycle
2014-2015
B.TECH. (AUTUMN SEMESTER) EXAMINATION
(ELECTRICAL/ CIVIL/ MECHANICAL/ ELECTRONICS/ COMPUTER/HEMICAL & PETRO CHEMICAL ENGG.)
ENGINEERING MATERIALS & MATERIAL SCIENCE
(AP-308) (Open Elective)

Maximum Marks: 60 Credits: 04 Duration: Three Hours

Answer ALL the questions. Notations used have their usual meaning.

1(a) Explain ionic and electronic polarizabilities. Show that orientational polarization
\[ P_e = N \mu_r^2 E / 3 k_B T \] for polyatomic gases.

(b) Discuss the variation of spontaneous polarization of rochelle salt and barium titanate with
temperature.

(c) Describe the phenomenon of ferroelectricity. Give the main characteristics of piezoelectric
materials with two examples.

(d) Two parallel conducting plates are separated by 5 mm and the space between them is filled
with a dielectric of dielectric constant 4. The electric field intensity in the dielectric is \( 10^6 \)
volts/m. Calculate the free charge per unit area on the conducting plates and polarization \( P \) in
the dielectric.

\[ \text{(d')} \] The polarizability of No is \( 0.43 \times 10^{-40} \text{ F.m}^2 \). How much field is required to be applied to shift
the positive charges with respect to the negative charges by \( 5 \times 10^{-18} \text{ m} \)?

2(a) Define relaxation time and evaluate in-phase and out-of-phase components of polarization.

\[ \text{OR} \]

(a') What do you mean by dielectric loss? Show that dielectric loss is given by
\[ \tan \delta = \frac{\varepsilon_f - \varepsilon_r}{\varepsilon_r} \]

(b) Establish Einstein's relation for doped semiconductors. With help of suitable diagram, obtain
the expression for the potential barrier at the p-n junction.

(c) In a Si sample, electron concentration varies linearly from \( n = 10^{12} \text{ cm}^{-3} \) to \( n = 10^{16} \text{ cm}^{-3} \)
over the distance from \( x = 0 \) to \( x = 3 \mu\text{m} \) at room temperature. Calculate the
diffusion current density for a given semiconductor. Assume \( D_n = 35 \text{ cm}^2/\text{s} \).

3(a) Discuss Langevin's theory of paramagnetism. Show that the magnetic susceptibility of a
paramagnetic material is inversely proportional to the absolute temperature (Curie law).

Continued......2
(b) What are ferrites? How are they superior to ferromagnetic materials?

(c) The magnetic field in a diamagnetic material is \(1.2 \times 10^4\) Am\(^{-1}\). Calculate the magnetization and flux density in it, if its magnetic susceptibility is \(-4.2 \times 10^{-6}\). Also, compute the relative permeability of the material. (Given data \(\mu_0 = 4\pi \times 10^{-7}\))

4(a) Explain Meissner effect and type-I and type-II superconductors with the help of suitable diagrams. Write a note on high temperature superconductors.

(b) A superconducting tin has a critical temperature of 3.7K in zero magnetic fields and a critical field of 0.0306 Tesla at 0K. Find the critical field at 2K.

(c) Discuss Entropy and specific heat in the superconducting state. Show that specific heat at the transition from normal to superconducting state is a second order transition.

OR

4'(a) How the flux through a superconducting ring is quantized. Show that the magnetic flux through the superconducting ring is quantized in integral multiples of \(\hbar/\eta\).

(b) Nb has density of \(8.5 \times 10^3\) kg/m\(^3\) and has one conduction electron per atom. Its atomic weight is 93. Calculate the London penetration depth of superconducting Nb in nm. (\(m = 9.1 \times 10^{-31}\))

(c) Explain d.c. Josephson effect. Show that the supercurrent of superconducting pairs across the junction depends on the phase difference.
2014-15
B.TECH. (AUTUMN SEMESTER) EXAMINATION
OPEN ELECTIVE
SELECTED TOPICS IN COMPUTER ENGINEERING
CO-446N

Maximum Marks: 60
Credits: 04
Duration: Three Hours

Q.No. | Question | M.M.
--- | --- | ---
1(a) | Write at least three properties of a good algorithm. Name three algorithm design techniques. | [03]
1(b) | What do you mean by Pseudo-code? Explain clearly with a proper example. | [04]
1(c) | Write selection sort algorithm and compute its time complexity. | [08]

OR

1'(a) | Differentiate between best case, average case and worst case complexity. Compute best case and worst case time complexity for insertion sort algorithm. | [07]
1'(b) | Given \( F(n) = n^4 + 7n^3 - 10n^2 - 2n + 3n^2 - 17 \)
   Show that \( F(n) \) is \( \Theta(n^4) \) | [05]
1'(c) | Show that \( (2^{0.5})^\log_2 x = O(n^{0.5}) \), where \( \log \) means \( \log_2 \) | [03]

2(a) | Write an algorithm to delete the \( K \)th element from a linear array \( A \) and assign it to a variable \( \text{III:M} \) | [03]
2(b) | Suppose multidimensional arrays \( A \) and \( B \) are declared using \( A(2:2, 2:2) \) and \( B(1:3, 5:5, 10:6) \)
   (i) Find the length of each dimension and the number of elements in \( A \) and \( B \)
   (ii) Consider the element \( D[3, 3, 3] \) in \( B \). Find the effective indices \( E_1, E_2, E_3 \) | [06]
2(c) | Sort the following characters in alphabetical order using Quick sort algorithm. Show intermediate steps.
   ALIGARHMMOVMENT | [06]

3(a) | What do you mean by DEQUE? Name and describe its two variations. | [03]
3(b) Show the working of the algorithm that uses a stack S to find equivalent postfix expression P for an arithmetic expression Q written in infix notation as follows:

\[ Q: \frac{(A + B)}{D} \uparrow (F - E) * G \]

3(c) Given inorder traversal and postorder traversal of a binary tree T as follows:

Inorder: E A C K F H D B G
Postorder: E C K A H B G D F

Draw the tree T. Is this tree unique?

OR

3(c') What do you mean by a Heap? Build a max-heap for the following list of numbers:

50 17 80 90 35 56 95 50 65 75

4(a) Apply

(i) Preemptive Shortest Job first CPU scheduling algorithm and
(ii) Non-preemptive Shortest Job first CPU scheduling algorithm

for scheduling the following processes, given their CPU burst time and arrival time.

<table>
<thead>
<tr>
<th>Process</th>
<th>CPU Burst Time</th>
<th>Arrival Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>P1</td>
<td>8</td>
<td>0</td>
</tr>
<tr>
<td>P2</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>P3</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>P4</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>P5</td>
<td>7</td>
<td>5</td>
</tr>
</tbody>
</table>

Draw the Gantt chart and compute the average waiting time, for each of the two cases.

4(b) What do you mean by starvation in priority based CPU scheduling algorithms? Explain with a proper example. What is the solution for it?

4(c) Differentiate between paging and segmentation. Explain clearly with a proper example.

OR

4(c') What is a process control block? Draw a schematic diagram for a process control block.
2014-15
B.TECH. (AUTUMN SEMESTER) EXAMINATION
OPEN ELECTIVE
RENEWABLE ENERGY SOURCES
EE-421/EE-472

Maximum Marks: 60
Credits: 04
Duration: Three Hours

Answer all the questions.
Assume suitable data if missing.
Notations used have their usual meaning.

1(a) How does the per capita energy consumption related with growth and development? (06)
(b) What are the merits and demerits of non-conventional energy sources? (06)

OR

1'(a) What is the status of renewable energy in India?
(b) Explain the basic principle involved in latent energy storage system? (08)

2(a) With the help of neat diagram show the constructional details and describe the
working of a flat plate collector. What are its main advantages? (08)
(b) Explain the phenomenon of generation of e-h pair when solar energy is directed
towards a P-N Junction. (04)

3(a) Draw a neat diagram showing constructional details of Phosphoric Acid Fuel Cell
and explain its working. What do you mean by poisoning of fuel cell? (08)
(b) Explain main features of Direct Methanol Fuel Cell. (04)

OR

3'(a). Calculate the volume of a fixed dome type biogas digester for the output of 3 cows.
Also, calculate the thermal power available from biogas. Use the following data:
Retention time = 40 days
Dry matter produced = 2 kg/day/cow
Biogas yield = 0.22 cubic metre/kg of dry matter
Percentage of dry matter in cow dung = 18%
Density of slurry = 1090 kg/ cubic metre
Burner efficiency = 50%
Heating value of biogas = 23 MJ / cubic metre (06)

3'(b). What is meant by Energy Farming? What are the different biomass energy
resources? (06)

4(a). With the help of a schematic diagram, explain the operation of a Liquid metal-inert
gas carrier, closed cycle MHD generating system. (06)

4'(b). Derive the expression of power extracted by HAWT from wind.
A HAWT is installed at a location with free wind velocity of 15 m/s. The 80 m
diameter rotor has three blades attached to the hub. Find the rotational speed of the
turbine for optimum energy extraction. (06)

5. Answer ANY THREE of the following:
(a). With the help of a labelled diagram, explain the layout of a typical micro hydro
plant. (12)
(b). Draw the layout of a Double-flash Wet Steam High Temperature Hydro thermal
System. What are the major differences between geothermal resources based
hydrothermal plants and conventional thermal plants?
(c). Explain thermoysis of water and biophotolysis methods used for production of hydrogen for use as energy carrier. Also, comment on the safety issues related to the use of hydrogen.

(d). Derive an expression of the average actual tidal power generated in one filling or emptying of the basin of a tidal plant.
Also, calculate the average power generated by the plant in single emptying process of the basin, if the basin area is 2 km², average tidal range is 13 m, the turbine-generator efficiency is 0.7. The turbine stops operation when the head on it falls below 3 m.

(e). Calculate the required flow rate of water in tonnes/minute for a 30 MW OTEC plant if ocean surface temperature is 27°C and the temperature at 1 km depth is 4°C. Explain the Claude-cycle based OTEC plant.
2014-2015
B.TECH./B.ARCH. (AUTUMN SEMESTER) EXAMINATION
(OPEN ELECTIVE)
AIR POLLUTION TECHNOLOGY
(MP-425)

Maximum Marks: 60
Credits: 04
Duration: Three Hours

Answer all the questions.
Assume suitable data if missing.
Notations used have their usual meaning.

Q.No.

1(a). Explain Air-Water-Land exchanges and the Pollution cycle.

1(b). Describe Planetary boundary layer on Earth’s surface and discuss how does the mechanical and convective turbulence affect the pollutant dispersion in atmosphere?

OR

1'(a). Discuss the purpose of modelling Atmospheric Interactions and describe the interrelationship between Air Quality Models, Air Monitoring and Air Quality Criteria.

1'(b). For a township, applying PINDEX scheme for Air Pollution Severity, the following values were obtained (after applying Tolerance Factors)

\[
\text{PINDEX}=1.4
\]

- Particulate Matter (PM) = 0.381
- Sulphur Oxides (SO\(_2\)) = 0.086
- Nitrogen Oxides (NO\(_x\)) = 0.204
- Carbon Monoxide (CO) = 0.181
- Hydrocarbons (HC) = 0.111
- Oxidants (OOO) = 0.361

Calculate SYNERGISM and explain its significance.

\[...\]
2. Describe in detail the formation mechanism of Nitric oxide (thermal, fuel bound and prompt) in combustion systems.

OR

2'. Describe the mechanism of formation of Carbon monoxide, Sulphur oxides and Organic pollutants.

3. Describe the methods of sampling suspended particulates by High Volume Filtration and by Impingement.

OR

3'. What do you understand by Chemiluminescence technique? With the help of schematic diagram, explain the working of a Chemiluminescent NO/NOx analyzer.

4(a). Briefly mention the techniques used to remove particulates from polluted gas streams. Describe Wet Scrubbers in detail.

4(b). Methane is to be destroyed in a Flare. The flow rate is 0.25 m$^3$/s at 3 bar and 25°C. Assuming that the personnel will not be exposed to flare for periods exceeding 20 minutes, find the height of the flare above the ground if its diameter is 0.2 m. Take the lower calorific value of methane as 50 MJ/kg.

5. Write short notes on any two of the following
(i) Sources of Evaporative Emissions in Petrol Engines
(ii) Exhaust Emissions from Diesel Engines
(iii) Three-way catalytic converter
1(a) What are differences between reciprocating and centrifugal pump.

1(b) A centrifugal pump impeller has an outer dia 30 cm and inner dia 15 cm, runs at 1200 rpm. The vanes are set at an angle of 30° at the outlet. If the velocity of flow is constant at 2 m/s. Calculate:

(i) The velocity and direction of water at outlet.
(ii) The head developed when \( \eta_{mech} = 0.85 \).
(iii) The blade angle at the inlet.

OR

A centrifugal pump lifts water under a static lift of 40 m of which 3 m is suction lift. The suction and delivery pipes are both 35 cm dia. The friction loss in suction pipe is 2 m and in delivery pipe is 6 m. The impeller is 0.5 m dia and 3 cm wide at outlet and runs at the speed of 1200 rpm. The exit blade angle is 20°. If \( \eta_{mech} = 85% \), determine the pressure at the suction and delivery ends.

2(a) Derive an expression for pressure head due to acceleration of the piston of a reciprocating pump on the suction.

2(b) A single acting reciprocating pump has cylinder dia = 10 cm, stroke = 25 cm, static suction head = 4.0 m, suction pipe length = 6.0 m, dia of suction pipe = 5.0 cm, crank speed = 30 rpm, estimate the pressure head on the piston at the beginning, middle and end of the stroke. (k = 0.02).

3 For an axial fan stage with downstream guide vanes (DGV) derive the expression for
(i) stage work, \( W_s \)  
(ii) stage pressure coefficient, \( \psi \)  
(iii) pressure rise in the rotor, \( (\Delta p)_{rots} \), 
(iv) Degree of reaction, \( R \).
A centrifugal fan has the data: inner dia of the impeller = 18 cm, outer dia = 20 cm, N=1450 rpm. The relative and absolute velocities at entry and exit are 20 m/s, 21 m/s, 17 m/s, 25 m/s. Flow rate is 0.5 kg/s, motor efficiency is 78%. Determine:

(i) the stage pressure rise (ii) degree of reaction (iii) the power to drive the fan.

The conditions of air at the entry of an axial compressor stage are \( p_1 = 768 \) mm of Hg and \( T_1 = 914 \) K. The air angles are \( \beta_1 = 51^\circ \), \( \beta' = 9^\circ \), \( \alpha_1 = \alpha_3 = 7^\circ \). The mean dia and peripheral speed are 50 cm and 100 m/s. Mass flow rate through the stage is 25 kg/s, the work done factor is 0.95 and mechanical efficiency is 92%, take stage efficiency 88%, determine: (i) air angle at the stator entry (ii) blade height at hub-tip dia ratio (iii) stage loading coefficient (iv) stage pressure ratio (v) power to drive the stage.

OR

4' Draw the b-s diagram for a complete axial flow compressor stage with \( R > 1/2 \) and prove that \( R = 1/2 - 1/2 \left( \frac{V_f}{u} \right) \left( \tan \alpha' - \tan \beta' \right) \). What is surging in axial flow compressor? What are its effects?

5(a) Define the unit and specific quantities and derive the expression for unit speed. And also derive the expression for flow coefficient, head coeff and power coeff.

5(b) Test on a centrifugal pump indicate that when driven at 2000 rpm, it discharges 10 m\(^3\)/min against a head of 100 m. At this condition the input is 300 KW. If a geometrically similar pump twice the size runs at 1500 rpm, find (i) discharge (ii) head (iii) power for the same efficiency.
1(a) Perform two iterations of Bairstow method to extract a quadratic factor \( x^2 + px + q \) from the polynomial
\[
x^2 + x^2 - x + 2 = 0.
\]
Take \( p_0 = -0.9 \) and \( q_0 = 0.9 \).

(b) Use two iterations of Newton Raphson's method to determine a root of nonlinear equations
\[
\log_e(x^2 + y^2) - 1 + y = 0
\]
\[
\sqrt{x} + xy = 0.
\]
Take \( x_0 = 2.4 \) and \( y_0 = -0.6 \).

(c) State Gershgorin's theorem and use it to estimate the eigen values of the matrix
\[
A = \begin{bmatrix}
1 & 2 & -1 \\
1 & 1 & 1 \\
1 & 3 & -1
\end{bmatrix}.
\]

OR

(e') Obtain the Chebyshev linear polynomial approximation to the function \( f(x) = \frac{1}{x^3} \) on \([1, 2]\). Also estimate the maximum error.

2 Answer any three of the following:

(a) Evaluate \( \int_0^1 \left( 1 + \frac{\sin x}{x^2} \right) dx \) correct to 3-decimals, using Simpson's rule with the number of points 3, 5 & 9. Improve the result by using Romberg integration.

(b) Obtain an approximate value of
\[
1 - \int_1^2 (1 - x^2)^{\frac{1}{2}} \cos x \, dx
\]
by using Gauss-Legendre and Gauss-Chebyshev 3-point formulae.
(c) Use Runge-Kutta method of fourth order to solve the system
\[
\frac{dx}{dt} = 2x + y, \quad \frac{dy}{dt} = x - 3y
\]
with \(x(0) = 0\) and \(y(0) = 0.5\) at \(t = 0.2\) in one step.

(d) Solve the boundary value problem
\[
y'' = y \text{ with } y(0) = 0 \text{ and } y(1) = 1
\]
by shooting method up to 4-decimals.

3(a) Find an approximate solution of the Laplace equation
\[
\frac{\partial^2 u}{\partial x^2} + \frac{\partial^2 u}{\partial y^2} = 0
\]
in the square,
\[
R = \{(x, y) : 0 \leq x \leq 4, 0 \leq y \leq 4\}
\]
with boundary conditions:
\[
u = 0 \text{ at } x = 0 \text{ and } u = 12 + y \text{ at } x = 4,
\]
\[
u = 3x \text{ at } y = 0 \text{ and } u = x^2 \text{ at } y = 4,
\]
with \(h = 1 = k\). Use one iteration of Gauss-Seidel's method to improve the values of \(u\) at the internal mesh points up to 2-decimals.

(b) Solve the Heat conduction equation
\[
\frac{\partial u}{\partial t} = \frac{\partial^2 u}{\partial x^2}
\]
subject to the boundary conditions:
\[
u = \sin \pi x \text{ at } t = 0, 0 \leq x \leq 1 \text{ and } u(0, t) = 0 = u(1, t),
\]
by using four iterations of Gauss-Seidel method up to one time level. Take \(h = 0.2\) and \(k = 0.02\).

(b') Solve the wave equation
\[
\frac{\partial^2 u}{\partial t^2} = \frac{\partial^2 u}{\partial x^2}
\]
with boundary conditions:
\[
u(0, t) = 0 = u(1, t), \quad \frac{\partial u}{\partial x}(x, 0) = 0 \text{ and } u(x, 0) = x - x^2, \text{ up to two time levels. Take } h = 0.25 \text{ and } k = 0.2 \text{ and write answers correct to two decimals.}

4(a) Obtain a two parameter solution of the boundary value problem:
\[
y'' + y + 1 = 0, \quad y(0) = 0 = y(1)
\]
by Galerkin and collocation methods.

(b) Solve the boundary value problem:
\[
u'' - u = x, \quad u(t) = 0 = u(1)
\]
by finite element method for \(h = \frac{1}{4}\).
1(a) Differentiate amongst the following with suitable example.
- sin and sind
- exp and expm
- clear and clear all
- / and \ 
- help and help topic

OR

1(a') By generating the row vector of different lengths how shall you evolve 5x5 matrix on command prompt using different forms of 'diag' command? Now elaborate the instructions needed on the command prompt that shall transform the developed matrix into another one having diagonal elements zero while retaining other elements.

1(b) Create the database for three employees using cell array storing information about employee code, name, designation and salary. Elaborate the commands to access the salary information of the employee.

2 The permeability of air through a thin soap film varies with temperature as
\[ k_p = \alpha \sqrt{T e^{6}} \]

Where \( k_p \) is the permeability (m/s), \( \alpha \) is a constant (ms\(^{-1}\)K\(^{3.5}\)), T is absolute temperature in K, E is activation energy for hole formation (J mol\(^{-1}\)), and \( R \) is universal gas constant (8.314 J mol\(^{-1}\) K\(^{-1}\)). How \( E \) and \( \alpha \) can be determined using following command functions of the MATLAB on command window, 'polyfit', 'nlfit' and 'v'

<table>
<thead>
<tr>
<th>( k_p (m/s) )</th>
<th>1( \times )10(^{3} )</th>
<th>1.5( \times )10(^{3} )</th>
<th>2.15( \times )10(^{3} )</th>
</tr>
</thead>
<tbody>
<tr>
<td>T (K)</td>
<td>294</td>
<td>303</td>
<td>313</td>
</tr>
</tbody>
</table>
2(a) The polynomials $A$ and $B$ are given as:

$$A = 4x^3 + 5x + 3, \quad B = x^2 + 3x + 6.$$  Write down the instructions on the command prompt to do the following showing the form of the result that shall come.

1. Multiplication of polynomials $A$ and $B$
2. Differentiate the multiplication of $A$ and $B$ polynomials.
3. Determine the roots of the result obtained from 2.
4. Evaluate the polynomials value at given $x$ from the 1.
5. Differentiate the rational functions obtained by dividing polynomial $A$ with polynomial $B$.

2(b) Write a function code to be typed on editor window of MATLAB to calculate percentage and division from set of marks obtained by a student.

3(a) Consider the following linear programming pertaining to blending of two raw materials (quantities represented by $x_1$ and $x_2$) to obtain the product.
The profit function

$$Z = 150x_1 + 175x_2$$

Total materials used

$$7x_1 + 11x_2 \leq 77 \quad \text{(Availability constraint)}$$

Total time

$$10x_1 + 8x_2 \leq 80 \quad \text{(Time constraint)}$$

Storage

$$x_1 \leq 9, \quad x_2 \leq 6, \quad x_1 \text{ and } x_2 \geq 0 \quad \text{(Storage constraints)}$$

Develop linear programming formulation on MATLAB to maximize the profit.

3(a') Let the transfer functions of the two systems be given by:

$$G_1(s) = \frac{10}{(s + 1)(s + 2)} \quad \text{and} \quad G_2(s) = \frac{2}{s(s^2 + 4)}.$$  Write the command to determine the overall transfer function for series, parallel and feedback arrangement. What are the commands required to get the plot under unit step response for these arrangements?

3(b) Elaborate the following with suitable example

- Fuzzy membership function
- Transfer function in ANN

4 Write step by step procedure to develop Simulink model described by the following dynamic equations to get the response for the unit step.

$$x_1 = x_2$$

Assume initial condition to be zero.

$$x_2 = -2x_1 - x_2 + u(t)$$