1. (a) Solve the following equations by using Gauss-Elimination method.
   \[27x + 6y - z = 85\]
   \[6x + 15y + 2z = 72\]
   \[x + y + 54z = 110\]

   (b) Solve by Gauss-Seidal method of iterations, the equations
   \[54x + y + z = 110\]
   \[2x + 15y + 6z = 72\]
   \[-x + 6y + 27z = 85\]

   Perform four iterations.

   (i) Apply Newton-Raphson Method to derive iteration formula for finding the cube root of a positive number \(C\). Hence find cube root of 12. Give three iterations.

   (ii) Find a real root of the equation \(x^4 - x - 9 = 0\) by Newton Raphson method correct to three places of decimal.

   (c) Apply the iterative method to find a real root of \(x^3 + x^2 - 1 = 0\), assuming the initial approximation as \(x_0 = 0.8\).

2. (a) Prove with the usual notations that

   (i) \(\frac{1}{E^2 + E^{-2}} \left(1 + \Delta \right)^{\frac{1}{2}} = 2 + \Delta\)

   (ii) \(\mu \delta = \frac{1}{2} (\mu + \nu)\)

   OR

   (a) Find missing term, given that
   \[
   \begin{array}{cccccc}
   x & 100 & 101 & 102 & 103 & 104 \\
   y & 2 & 2.0043 & ? & 2.0128 & 2.0170 \\
   \end{array}
   \]

   (b) From the following table, evaluate \(f(3.8)\) using Newton backward interpolation formula

   \[
   \begin{array}{cccc}
   x & 0 & 1 & 2 & 3 \\
   f(x) & 1.00 & 1.50 & 2.20 & 3.10 \\
   \end{array}
   \]

   (c) Give the values

   \[
   \begin{array}{ccccccc}
   x & 4 & 5 & 7 & 10 & 11 & 13 \\
   f(x) & 48 & 100 & 294 & 900 & 1210 & 2028 \\
   \end{array}
   \]

   Evaluate \(f(12)\) using Lagrange's formula.
3. (a) Given differential equation \( y'' - xy' - y = 0 \) with the conditions \( y(0) = 1 \) and \( y'(0) = 0 \) use Taylor’s series method to determine the value of \( y(0.1) \).

OR

(a') Determine the value of \( y \) when \( x = 0.1 \) given that \( y(0) = 1 \) and \( y' = x^2 + y \)
(take \( h = 0.05 \) with \( x_0 = 0 \) and \( y_0 = 1.0 \))
Use Modified Eulers’ method giving two iterations at each step.

(b) Using Runge – Kutta method of order to solve \( \frac{dy}{dx} = 1 + y^2 \), where \( y = 0 \)
when \( x = 0 \), Find \( y(0.2) \) and \( y(0.4) \). Take \( h = 0.2 \).

(c) Solve the boundary value problem
\[
\frac{dy^2}{dx^2} - y = 0 \text{ with }
\]
\( Y(0) = 0 \) and \( y(2) = 3.62686 \).
By finite difference method. Take \( h = 0.5 \)

4. (a) Solve the following linear programming problem graphically
Maximize \( z = y - 2x \)
Subject to the constraints
\( x \leq 2, \ x + y \leq 3, \ -2x + y \leq 1 \) and \( x, y \geq 0 \)

(b) Use simplex method to solve the following linear programming problem:
Maximize \( Z = 7x_1 + 5x_2 \) subject to the constraints.
\( x_1 + 2x_2 \leq 6 \)
\( 4x_1 + 3x_2 \leq 12 \)
\( x_1, x_2 \geq 0 \)

OR

b'. Show that \( x_1 = 0, \ x_2 = 0, \ x_3 = \frac{44}{77}, \ x_4 = \frac{45}{17} \) is the optimal basic feasible solution to the linear programming problem
Max \( Z = 2x_1 + 3x_2 + 4x_3 + 7x_4 \) Subject to the constraints.
\( 2x_1 + 3x_2 - x_3 + 4x_4 = 8 \)
\( x_1 - 2x_2 + 6x_3 - 7x_4 = -3 \)
\( x_1, x_2, x_3, x_4 \geq 0 \).
2014-2015
B.E. IV SEMESTER EXAMINATION
(MECHANICAL)
ELECTRICAL TECHNOLOGY
(EEE - 204)

Maximum Marks : 60          Duration: Three Hours

Note:  
. Attempt All Questions.
. All questions carry equal marks
. Assume suitable value for missing data, if any.

1a. What is a TRIAC? Discuss different modes of operation of the TRIAC. (4)

b. Discuss the advantages and disadvantages of the TRIAC over the SCR. (3)

c. What is an IGBT? What are its important properties compared to the power MOSFET? (2)

d. Mention the advantages of the power MOSFET over the power transistor (BJT). (3)

2a. Draw and explain the speed-armature current, torque-armature current, and speed-torque characteristics of a d.c. shunt motor. (4)

b. What happens in a d.c. shunt motor if its field circuit opens while it is running? (2)

c. A d.c. shunt motor has a full-load current of 50A and an armature circuit resistance of 0.2 ohm. Calculate the value of starting resistance required to limit the starting current to 150 % of the full-load current at a terminal voltage of 220V.

OR

2'a. List the different methods of speed control of the d.c. shunt motor. (3)

b. What are the drawbacks of three-point starter? Describe a four-point starter with a neat sketch. (1+4)

c. A 220V d.c. shunt motor on no-load runs at 1500 RPM and takes 5A input current from the supply. The armature circuit and shunt field winding resistances are 0.25 ohm and 220 ohms respectively. Calculate the speed when loaded and taking a current of 60 A from the supply, if the armature reaction weakens the field by 5%.
3a. Explain the principle of operation of a 3-phase induction motor. (3)

b. Draw the equivalent circuit of a 3-phase induction motor referred to stator side and name the various parameters of the equivalent circuit. (3)

c. A 3-phase induction motor has a starting torque of 100% of the full-load torque and a maximum torque of 200% of the full-load torque. Find the full-load slip. (6)

OR

3'a. What are the various techniques used to control the speed of a 3-phase induction motor? (2)

b. List the different starting methods of 3-phase induction motors. (2)

c. Draw the power-flow diagram of 3-phase induction motors. (2)

d. A 400V, 50 Hz, 3-phase induction motor draws 70A at 0.8 P.F. lagging. The stator copper losses are 2 kW and the rotor copper losses are 700W. The friction and windage losses are 600W, and the core losses are 1.5 kW. Find the following quantities:
   i. the air-gap power ($P_g$)
   ii. the mechanical power developed ($P_m$)
   iii. the shaft power ($P_o$)
   iv. the efficiency

4a. State some characteristic features of the synchronous motors. (3)

b. List different starting methods of synchronous motors. (3)

c. Explain the operation of a universal motor with simplified phasor diagram and circuit model. Mention its applications. (6)

5a. What is an autotransformer? Derive the KVA output (apparent output power) of an autotransformer in terms of the parameters of a two-winding transformer. (5)

b. Mention the applications of the autotransformers. (2)

c. A 400/100 V, 5 KVA two-winding transformer is to be used as an autotransformer to supply power at 400 V from 500 V source. Draw the connection diagram and determine the KVA output of the autotransformer. (5)

OR
5'a. What are the causes of low power factor? Discuss the disadvantages of low power factor. 

b. What is the best location to place the power factor improvement device?

c. List the methods of power factor improvement.

d. An industrial plant has an installed load of 350 KW operating at a power factor of 0.65 lagging. Determine the size of the capacitor bank (in KVAR) required to improve the power factor to 0.85 lagging.
2014-15
B.E. IV SEMESTER EXAMINATION
(MECHANICAL ENGINEERING)
MATERIAL SCIENCE
(EME-202)

Maximum Marks: 60

Duration: Three Hours

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

Q.No. Question M.M.
1(a) What is atomic packing fraction? Calculate the atomic packing fraction for BCC (06) structures.
1(b) What is a screw dislocation? Show Burgers circuit and Burger vector on a crystal (06) having screw dislocation

OR

1(b') Obtain Miller indices of a plane whose intercepts are 3Å, 4Å and 3Å on a, b, c axis (06) respectively in a simple tetragonal crystal, having c/a ratio of 1.5.

2.(a) What are different allotropes of Iron? Sketch them on an Iron-Carbon diagram. (08)
2.(b) What is a solid solution? What are Hume-Rothery rules? (04)

OR

2.(a) Explain the following heat treatment processes (08)
   i. Annealing
   ii. Normalising

2.(b) Differentiate between Austempering and Martempering. (04)

3.(a) What is diffusion of solids? State and explain Fick’s second law. (06)
3.(b) The carbon content of steel at the surface is 1% and is being carburized at 927°C. (06)
      The nominal carbon content in steel is 0.2%. Calculate the time needed to increase
      the carbon content to 0.5% at 0.6mm depth. \( D = 1.28 \times 10^{-11} \) m²/s at 927°C.

OR

3.(b') Differentiate between composite materials and polymers. Write short notes on (06)
   i. Aluminium
   ii. Glass

contd... 2
4. (a) State and explain generalized Hooke's Law.

4. (b) What is meant by Linear Elastic Fracture Mechanics? What are the different modes of Fracture?

OR

4. (b') Write short notes on the following
   i. Fatigue
   ii. Creep
   iii. Engineering stress and true stress

5. (a) What are the different types of corrosion? What common factors are always involved in corrosion?

5. (b) Explain any two of the following
   i. Dry corrosion
   ii. High temperature corrosion
   iii. Protection against corrosion and oxidation
2014-15  
B.E. (WINTER SEMESTER) EXAMINATION  
MECHANICAL ENGINEERING  
MACHINE DRAWING AND COMPUTER GRAPHICS  
EME-211 

Maximum Marks: 40  
Credits: 04  
Duration: Three Hours 

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

Q.No.  

1(a) Sketch the conventional representation of the following:  

(i) Porcelain  
(ii) Wood  
(iii) External screw threads  
(iv) splined shaft  

1(b) Sketch the following locking devices, with proportions marked, taking the bolt diameter as 20 mm:  

(a) Locking with split pinned nut  
(b) locking by sawn or wiles nut  

1(c) List 4 commands from Draw toolbar in AutoCAD giving their inputs required.  

1(d) Compare Rectangular Array and Polar Array with suitable illustrations.  

2 Draw the sectional elevation and left end view of a Bench Vice assembly for which the part details are shown in Figure 1.  

OR 

2' Assemble the parts and draw the sectional elevation and plan of the Plummer Block assembly for which the part details are shown in Figure 2.  

contd... 2
MOVING JAW with GUIDE (C.I.)

BODY (C.I.)

PEG (Steel)

SCREW with COLLAR (M.S.)

HANDLE (M.S.)

SPHERE, φ14

Fig. 1: BENCH VICE

contd... 3
Fig. 2: PLUMMER BLOCK
**2014-15**
**B. E. (WINTER SEMESTER) EXAMINATION**
**MECHANICAL ENGINEERING**
**KINEMATICS & DESIGN OF MACHINE**
**EME - 215**

**Maximum Marks: 60**

**Credits: 04**

**Duration: Three Hours**

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

<table>
<thead>
<tr>
<th>Q.No.</th>
<th>Question</th>
<th>M.M.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1(a)</td>
<td>Discuss in brief the Gruebler’s criterion for degree of freedom of a plane mechanism. Determine the degrees of freedom for the linkage shown in Figure 1.</td>
<td>[03]</td>
</tr>
<tr>
<td>1(b)</td>
<td>How are the kinematic pairs classified? Explain with examples.</td>
<td>[03]</td>
</tr>
<tr>
<td>1(c)</td>
<td>What is meant by inversion of a mechanism? List out the various inversions of slider-crank mechanism. Discuss the functioning of Crank and Slotted-Lever Mechanism.</td>
<td>[06]</td>
</tr>
</tbody>
</table>

**OR**

<table>
<thead>
<tr>
<th>Q.No.</th>
<th>Question</th>
<th>M.M.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1'(c)</td>
<td>Derive an expression for the fundamental equation of correct steering. Discuss in brief the Davis Steering Gear mechanism.</td>
<td>[06]</td>
</tr>
<tr>
<td>2(a)</td>
<td>State and explain the Kennedy’s theorem for the determination of secondary centros in a mechanism.</td>
<td>[02]</td>
</tr>
<tr>
<td>2(b)</td>
<td>A double slider mechanism is shown in Figure 2. The link lengths are specified as:</td>
<td>[10]</td>
</tr>
<tr>
<td></td>
<td>OA = 300 mm, AB = 600 mm, AC = BD = 1.2 m. OD is horizontal for the given configuration. If OA rotates at 200 rpm in the clockwise direction, determine:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>i. The linear velocities of C and D</td>
<td></td>
</tr>
<tr>
<td></td>
<td>ii. The angular velocities of links AC and BD, and</td>
<td></td>
</tr>
<tr>
<td></td>
<td>iii. The velocity of rubbing of pins A, C and D. The radii of pins are 30, 40</td>
<td></td>
</tr>
</tbody>
</table>

*Contd... 2.*
and 25 mm respectively.

OR

2' In the toggle mechanism shown in Figure 3, the crank OA rotates at 210 rpm counter-clockwise increasing at the rate of 60 \text{ rad/sec}^2. For the given configuration, determine

i. Velocity of slider D and angular velocity of link BD
ii. Acceleration of slider D and angular acceleration of link BD.

All the geometric dimensions are in mm.

3 (a) Define the following terms with neat sketch:

i. Path of approach
ii. Path of recess, and
iii. Path of contact between two mating gears

3 (b) If the interference between two involute gears is to be avoided, then prove that the maximum length of arc of contact will be equal to \((r+R) \tan \phi\).

Where \(r\) = pitch radius of pinion; \(R\) = pitch radius of gear, and \(\phi\) = pressure angle.

OR

3 (b') A simple gear train consists of three gears each mounted on a separate shaft. The shafts are parallel. Gear 1 meshes with gear 2, gear 2 meshes with gear 3. The gear 1 is the driver rotating clockwise at 1000 rpm and gear 3 is the follower. The number of teeth on gears 1, 2 and 3 are 20, 30 and 50 respectively. Find

i. Speed ratio of gear train
ii. Speed of the follower, and
iii. Direction of rotation of the follower.

4 (a) What do you mean by machine design? Also write the procedure used in designing.

4 (b) What do you mean by stress concentration? How the effect of stress concentration be minimized?

4 (c) What are the factors which affect the endurance strength? Explain any two.

Contd....3.
Figure 4 shows a rotating shaft supported in bearings at supports A and B and loaded by a non-rotating load 10 KN at the mid span. Estimate the life of the shaft, if it is made of steel having ultimate tensile strength of 550 MPa. All dimensions are in mm. Take $K_a = 0.85; K_b = 0.84; K_c = K_d = 1.0, q = 0.9$ and $K_t = 0.085$

Determine the forces acting on all the bolts, and the size of the bolts for the structural joint shown in Figure 5. The maximum shear stress is 140 MPa. All the geometric dimensions are in mm.
Figure 4

Figure 5