Faculty of Engineering & Technology

CINEC CAMPUS
Beyond A Graduate

Bachelor of Science Honours in Engineering in Civil Engineering

CE4322 Environmental Engineering

Final Examination -Resit

Module Leader: **Ms. Nimali Sugandika**

Academic Year: **2025**

Date: **08/28/2025**

Time: **0900– 1200 hours**

Instructions to Candidates:

- This paper contains five (04) questions. Answer **all four** questions.
- All questions do not carry equal marks.
- Write clearly and legibly with a blue or black pen.
- Write your name and student number on all sheets.
- Answers to different parts of the same question (other than any graph sheets used) should not be scattered.
- Marks will be deducted for missing or incorrect measuring units.
- You are advised to make a clear diagram for each question, where appropriate. This will help you to perform calculations correctly.
- Assume reasonable values for any data/information not provided with the exam paper (clearly state the assumptions)
- This is a **closed-book exam**, you are not allowed to bring in your study notes. Use of a calculator allowed.
- A graph sheet will be provided.

Question 1

(a) Explain the key steps involved in the EIA process. How does it help in minimizing environmental degradation? **(20%)**

(b) Evaluate the effectiveness of mitigation measures commonly suggested for minimizing air pollution in EIAs. **(20%)**

(c) Discuss the potential impacts of construction and industrial projects on water quality and aquatic ecosystems. **(20%)**

(d) Assess the challenges in predicting long-term land degradation from mining or large-scale infrastructure projects. **(20%)**

(e) How can EIA contribute to the sustainable management of river basins or coastal zones? **(20%)**

Question 2

(a) A community has experienced the growth in population and water use shown below. Estimate the population, per capita water use, and total average daily water demand in the year 2030 using the compound growth, arithmetic, uniform rate methods. **(30%)**

Year	1950	1960	1970	1980	1990	2000	2010
Population	8000	8990	11300	14600	18400	23500	28700
Average daily flow m^3	1600	1900	2500	3285	4150	5400	6750

(b) Define coagulation and flocculation. How does the Jar Test help optimize these processes? **(10%)**

(c) Discuss the environmental and economic considerations when selecting a coagulant based on Jar Test results. **(10%)**

(d) Design a static mixer for the following conditions: **(50%)**

Design flow rate 550 m^3/h

Minimum water temperature 10 ^0C

Mixer aspect ratio 1.5

Design COV is 1%

To complete this design, specify the following: number of static mixers, number of mixing elements, and mixer diameter.

Question 3

(a) Solid waste management is not just a technical issue but also a social and economic one. Discuss. **(20%)**

(b) What are the key elements of a successful municipal solid waste management system? Discuss with reference to case studies. **(20%)**

(c) How does improper management of solid waste contribute to climate change? What can be done to minimize its carbon footprint? **(20%)**

(d) Explain the main stages of wastewater treatment: primary, secondary, and tertiary treatment. **(20%)**

(e) What are the economic and social barriers to implementing effective wastewater management systems in rural areas? **(20%)**

Question 4

(a) Explain the problem with algae considering the drinking water treatment process. **(10%)**

(b) Explain reasons for the water hardness. **(10%)**

(c) It is required to design the flocculation tank for a Water Treatment Plant located in Ratmalana by providing the following for the first two compartments only. The design flow rate is 0.050 m^3/s. The average water temperature is 8 ^0C. **(80%)**

1. Water power input in kW

2. Tank dimensions in m

3. Diameter of the impeller in m

4. Rotational speed of impeller in rpm

Use the following assumptions:

1. Number of tanks 1 (with 1 backup)

2. Tapered G in three compartments: 60, 50, and 20 s^{-1}

3. Detention time 30 min

4. Depth 3.5 m

5. Impeller type: axial-flow impeller, three blades, Np 0.43

6. Available impeller diameters: 1.0, 1.5, and 2.0 m

7. Assume B $(1/3)H$

Additional information

Geometric ratio	Range
D/T (radial)	0.14–0.5
D/T (axial)	0.17–0.4
H/D (either)	2–4
H/T (axial)	0.34–1.6
H/T (radial)	0.28–2
B/D (either)	0.7–1.6

D = impeller diameter

$$T = \text{equivalent tank diameter} = \left(\frac{4A}{\pi}\right)^{0.5}$$

A = the plan area
H = water depth
B = water depth below the impeller

$$G = \left(\frac{P}{\mu \forall}\right)^{1/2}$$

where G = global RMS velocity gradient, s^{-1}

P = power of mixing input to vessel, W

μ = dynamic viscosity of water, $Pa \cdot s$

$\forall$ = volume of liquid, m^3

$$P = N_p(n)^3(D_i)^5\rho$$

where P = power, W

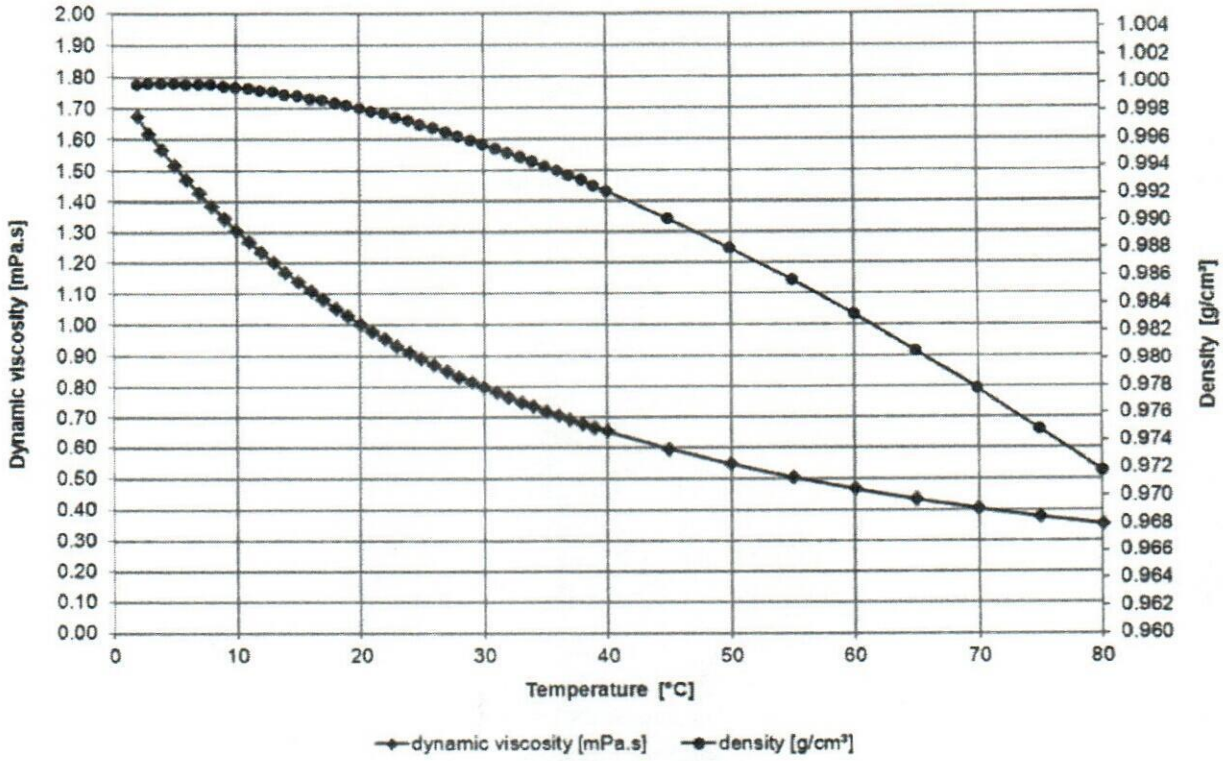
N_p = impeller constant (also called power number)

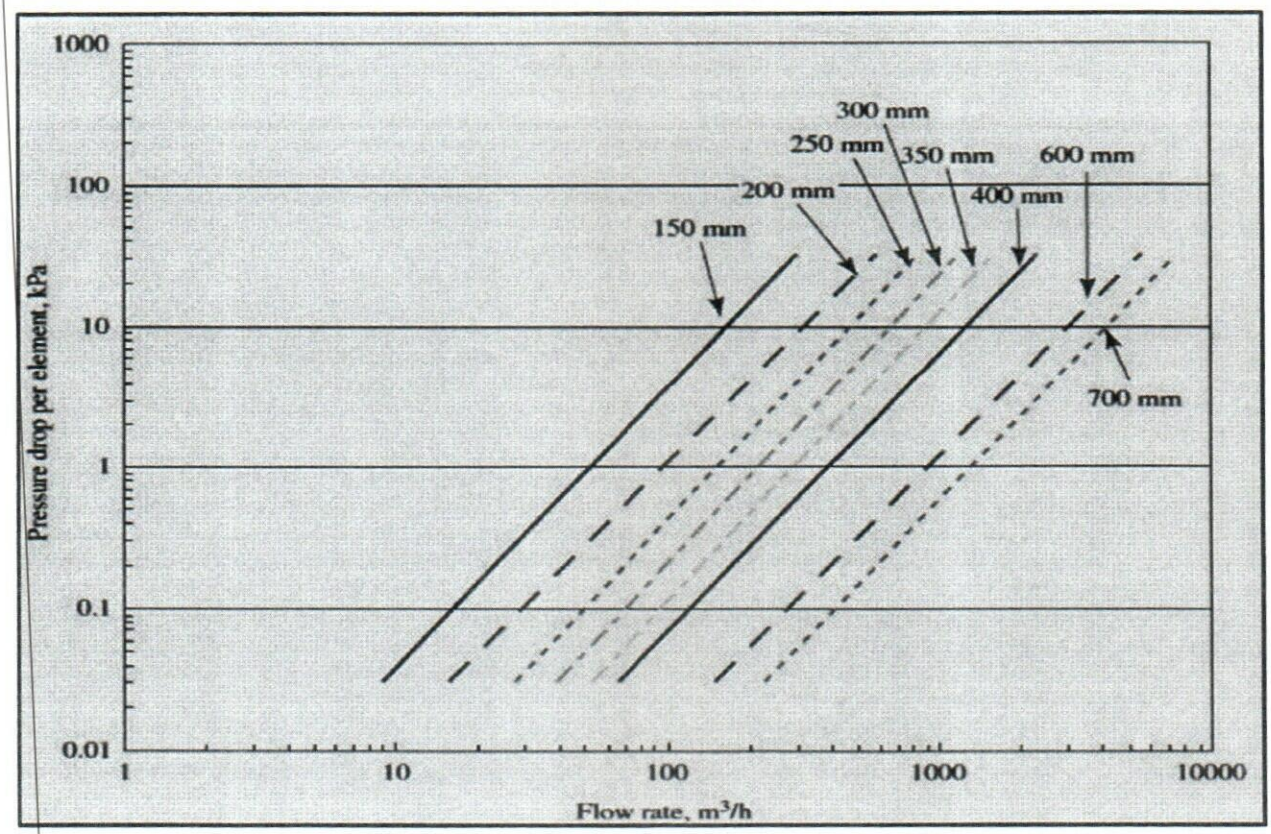
n = rotational speed, revolutions/s

D_i = impeller diameter, m

ρ = density of liquid, kg/m^3

This graph can be used to find out the dynamic viscosity and the density of the fluid, if it is not given.





$$P = \frac{\gamma Q H}{\eta}$$

where P = water power, kW

γ = specific weight of fluid, kN/m^3

= 9.807 kN/m^3 for water at 5°C

Q = flow rate, m^3/s

H = total dynamic head, m

η = efficiency

$$P = P_o \left(1 + \frac{r}{n}\right)^{nt}$$

P: Population Accumulated
Po: Initial Population
r: Growth Rate (decimal)
n: Compounding per period
t: number of periods (years)

$$t = \frac{V}{Q}$$

where t = theoretical detention time, s

V = volume of fluid in reactor. m^3

Q = flow rate into reactor, m^3/s

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Faculty of Engineering & Technology

Department of Civil Engineering

Bachelor of Science Honours in Engineering

Year 1 Semester 1 Final Examination 2024/2025

Module Code	:	**CE1313**
Module Title	:	**Properties of Materials**
Date/Time	:	**21st August 2025 / 09.00 am – 12.00 noon**
Examiner	:	**P.W Gavithra Udayakumara**
Time Allowed	:	**Three hours only**

INSTRUCTIONS TO CANDIDATES

- This is a **closed book** examination.
- "Section A" consists of 10 Multiple Choice Questions. You should attempt **ALL** questions.
- Section B consists of 4 questions. You should attempt all 4 questions.
- Show all stages of your work.
- This paper contains 09 pages.

MATERIALS REQURIED

- Answer Booklet.
- You may use a scientific calculator. This must not be programmable and may be inspected during the examination.
- Extra answer papers (if required)
- Equations are mentioned at the 9th page

Student Number .....

SECTION A

1. Radioactive materials are using for various purposes. A γ-ray source is delivered with 10mCi of radio-cobalt, half-life 3 months and is due for renewal when the activity has fallen to 1.5mCi. How often will renewal be necessary?
   a) 4.3 months
   b) 5.6 months
   c) 7.4 months
   d) 8.2 months
   e) 9.5 months

2. An engineering team is working on designing a critical component for an aircraft that will be subjected to cyclic loading during its operational life. The team is concerned about the potential for fatigue failure and is exploring various materials and design strategies to mitigate this risk. What is the significance of conducting fatigue testing during the design phase of the component?

   a) To determine the hardness of the material
   b) To identify the yield strength of the material
   c) To assess the material's response to cyclic loading and predict fatigue life
   d) To measure the material's thermal conductivity
   e) To determine the Ultimate Tensile Strength and Yield Strength of the material

3. Which of the following statements correctly distinguishes crystalline and amorphous materials?
   a) Crystalline materials have long-range order, while amorphous materials lack long-range order.
   b) Crystalline materials are always transparent, while amorphous materials are always opaque.
   c) Amorphous materials have regular atomic arrangements, while crystalline do not.
   d) Both crystalline and amorphous materials exhibit identical unit cells.
   e) Crystalline materials exist only in metals, not in ceramics

4. A photovoltaic cell (solar cell) is designed to convert sunlight into electrical energy. It relies on a p-n junction to generate a voltage when exposed to light. The cell is made using a semiconductor material doped to create p-type and n-type regions. Which of the following statements best explains the role of extrinsic semiconductors in the functioning of a photovoltaic cell?
   a) Intrinsic semiconductors are used exclusively because they generate electrons and holes equally.
   b) Extrinsic semiconductors form the p-n junction, which separates charge carriers created by light absorption.
   c) The p-type material absorbs photons, while the n-type material blocks recombination of charge carriers.
   d) Extrinsic semiconductors are unnecessary because sunlight itself provides all required carriers.

5. A mobile phone manufacturing company wants to design a battery management circuit using silicon as the semiconductor base. The engineers must decide whether to use intrinsic silicon or doped extrinsic silicon for effective conduction at room temperature. The design requires a material with higher conductivity and reliable performance under varying temperatures.
Which of the following statements best explains why extrinsic silicon (doped) would be preferred over intrinsic silicon in this application?

a) Intrinsic silicon has a very high conductivity at room temperature, making it unsuitable for controlled conduction.
b) Doping increases the forbidden energy gap, reducing the chances of unwanted conduction.
c) Extrinsic silicon introduces donor or acceptor impurities, increasing the number of charge carriers significantly.
d) Intrinsic silicon contains both electrons and holes in equal numbers, leading to unstable device performance.
e) Doping decreases mobility of carriers, which directly increases conductivity.

6. An FCC structure (e.g., in metals like aluminum, copper, gold, and nickel) has the highest packing efficiency among cubic systems, meaning atoms are closely packed with minimal empty space. The Atomic Packing Factor (APF) of a Face-Centered Cubic (FCC) structure is approximately.

a) 0.40 (40%)
b) 0.52 (52%)
c) 0.60 (60%)
d) 0.68 (68%)
e) 0.74 (74%)

7. What is the role of crack tip radius in fracture toughness?

a) Larger crack tip radius increases fracture toughness
b) Smaller crack tip radius increases fracture toughness
c) Crack tip radius does not affect fracture toughness
d) Crack tip radius is unrelated to fracture behavior
e) No relationship between crack tip radius and fracture toughness.

8.Plastic deformation of metals takes place most commonly by
(a) Annealing process, involving the removal of dislocations
(b) Stretching of bonds under the influence of an externally applied stress.
(c) The slip process, involving the movement of dislocations.
(d) Work hardening process, involving the entanglement of dislocations.

9. An engineering team is designing a bridge structure. The team is designing a bridge that needs to withstand heavy loads and potential earthquakes. Which type of failure, ductile or brittle, is more desirable for this application, and why?
   a) Ductile failure because it allows for deformation and energy absorption before complete failure, which is crucial for withstanding dynamic loads.
   b) Brittle failure because it provides early warning signs through visible deformations, allowing for timely maintenance.
   c) Ductile failure because it results in sudden, catastrophic failure, reducing the chances of progressive collapse.
   d) Brittle failure because it ensures better load distribution across the structure

10. Which of the following statement is true?

   a) The electrical conductivity is directly proportional to both the number of free electrons and the electron mobility.
   b) The electrical conductivity is inversely proportional to both the number of free electrons and the electron mobility.
   c) The electrical conductivity is directly proportional to the number of free electrons but inversely proportional to the electron mobility.
   d) The electrical conductivity is inversely proportional to the number of free electrons but directly proportional to the electron mobility

SECTION B

Question 01

Composites can be defined as a material consisted with customized properties to meet the prevailing requirement of the various engineering disciplines. Cost effectiveness, improved stiffness and oxidation resistance are among those improved characteristics. Assume you have been allocated for research and development team in manufacturing continuous and aligned glass - fiber reinforced plastic with optimized mechanical properties. As per the obtained results, the composite consists of 35% glass- fibers and the remaining portion with plastic matrix. The elastic moduli of glass fiber and plastic are 160GPa and 30GPa. Respective tensile strengths are 4600MPa and 400MPa. If the composite subjected to a load of 64,000N parallel to the fibers and having the cross sectional area of 1000mm2, answer the following questions.

a) Briefly explain how "rule of mixture" theory can be used to ensure the applicability of new product with the aid of graph. (Upper bound and lower bound graphs can be assumed by yourself)
b) The modulus of elasticity of this composite in the longitudinal direction.
c) The fiber-matrix load ratio.
d) Strain experienced by the matrix.
e) Name 3 types of polymer matrix composites and mention 2 applications for each of those.
f) "A materials engineer is tasked with selecting a metal for a new aerospace component. The design requires high strength and resistance to deformation. Discuss how the choice of crystal structure (SC, BCC, FCC) would influence the mechanical properties, atomic packing factor, and overall suitability of the metal for aerospace applications.

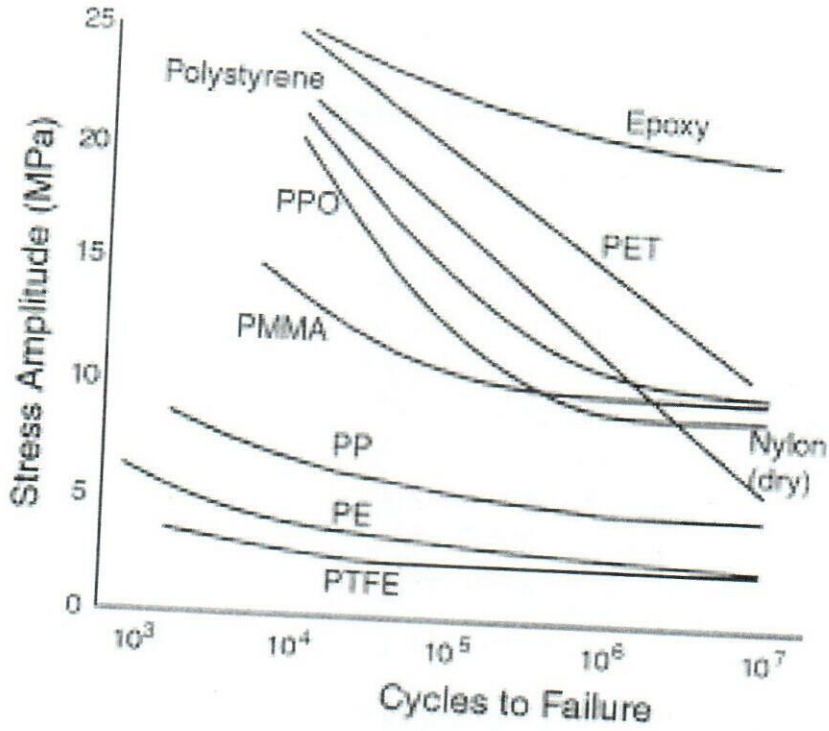
Question 02

Material failure can be mentioned as unfavorable incidents which lead to economic losses as well as some human injuries as well.

a) Explain the mechanism of fatigue failure with the aid of diagram

b) Determine the "constant representing the structural detail" and the "Slope coefficient of mean test result line" by using the data given below with reference to the given graph

   a. PE $\{(10^3, 6), (10^4, 4)\}$
   b. PMMA $\{(10^4, 17), (10^5, 12)\}$

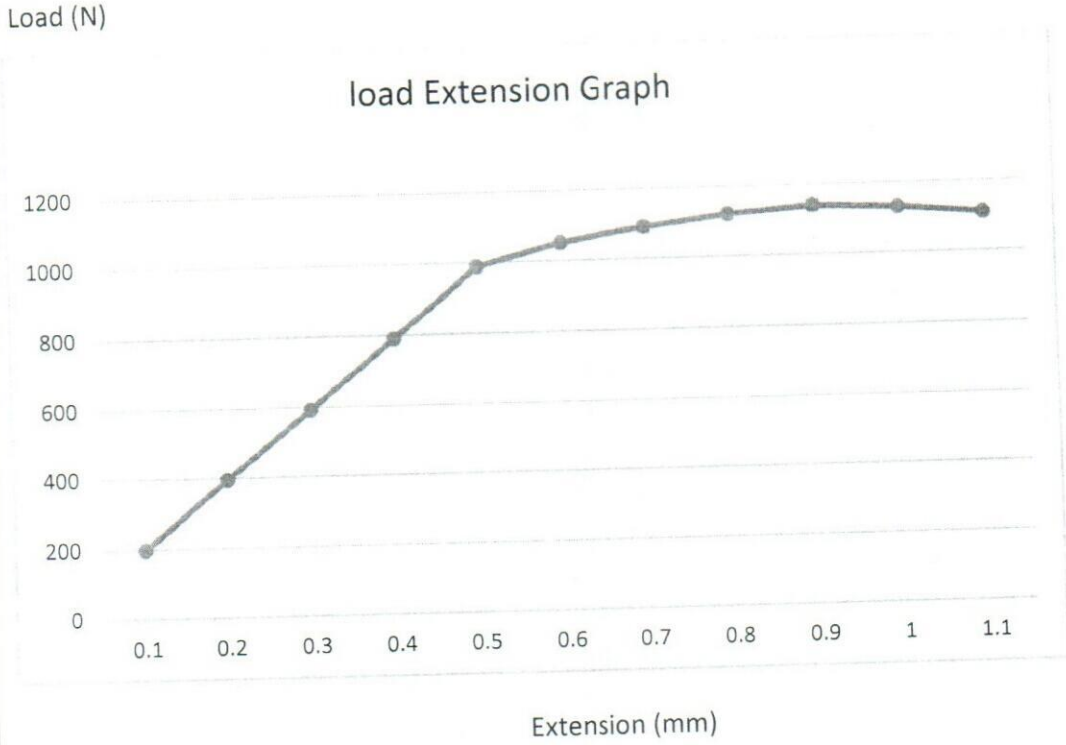


c) Determine the endurance limit for above two.
d) Briefly explain the importance of "endurance limit" during the selection of material for engineering application.
e) Some aircraft component is fabricated from aluminum alloy that has a plane strain fracture toughness of 40MPam$^{.5}$. It has been determined that fracture results at a stress of 300MPa when the maximum internal crack length is 4.0mm. For this same component and alloy, will fracture occur at a stress level of 260 MPa when the maximum internal crack length is 6.0mm? Briefly explain this scenario.

Question 03

Strength of materials recommends as one of the critical engineering properties to be concerned during the designing purposes. Tensile test reveals some important parameters with regarding to the strength of the materials.

a) Mention the process of calculating the tensile strength of brittle materials with the aid of sketch and respective equation.
b) Tensile stress applies along the longitudinal direction of cylindrical shaped steel front axle of a motor vehicle which is having the diameter of 120mm. If the maximum permissible diameter change of the axle is 18* 10^{-3} mm, calculate the critical tensile strength that can be applied to the rod without being subjecting in to failure. Poisson's ratio for steel is 0.28 and modulus of elasticity is 200GPa.
c) Calculate the Yield stress, Ultimate tensile stress and the elastic modules of the material shown in the graph. {[0.1, 197.5], [0.2,395], [0.3, 592.5], [0.4, 790], [0.5,987.5], [0.6, 1050], [0.7,1090], [0.8, 1120], [0.9,1140], [1, 1130], [1.1,1110]}

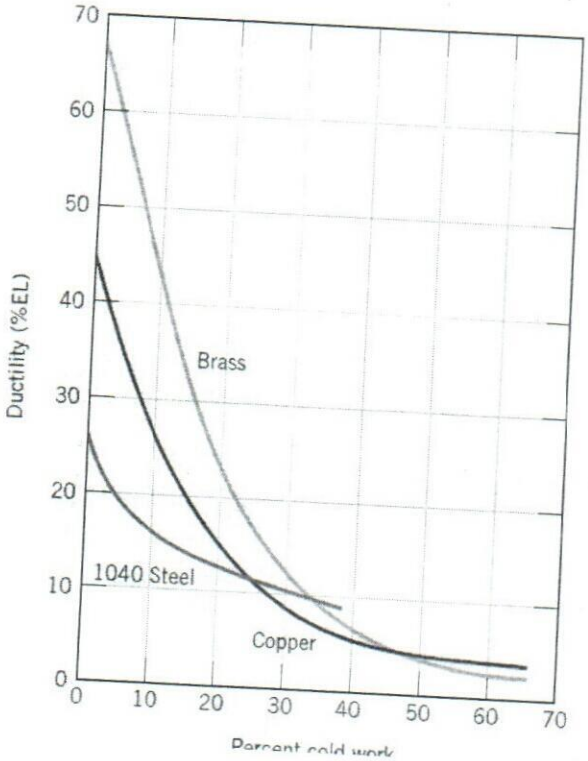


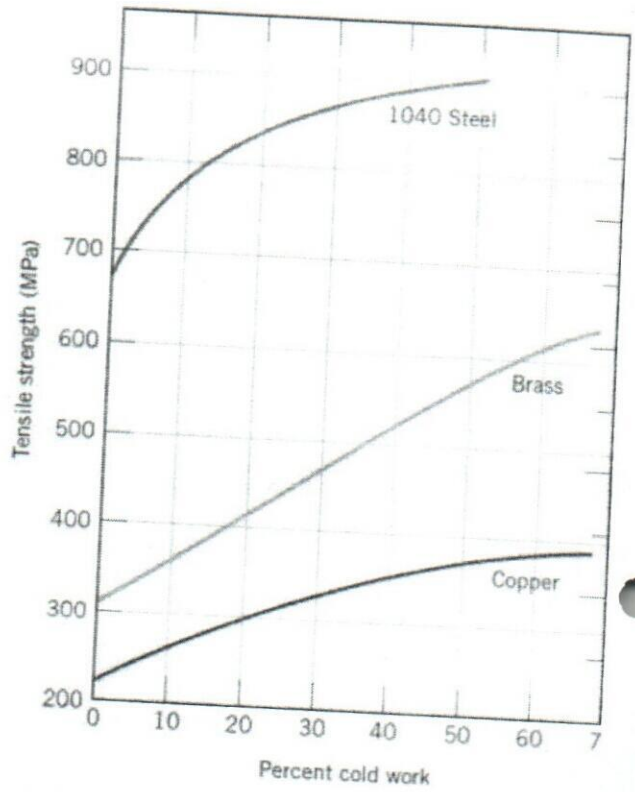
d) Briefly explain the Crevice corrosion and galvanic corrosion with respective figures.
e) Briefly explain 3 methods that can be used to prevent the corrosion of metals with related expels to illustrate the importance in engineering related applications

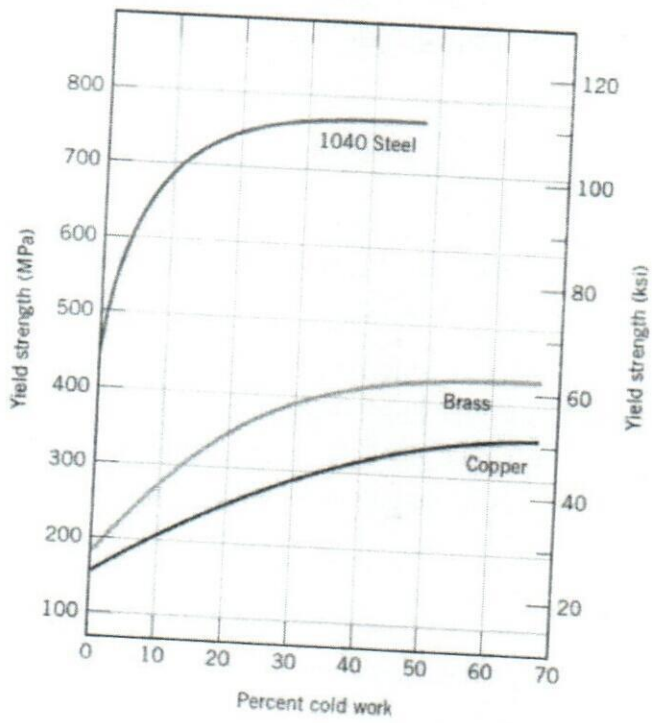
Question 04

Strain hardening defines as a scenario where a ductile metal becomes harder and stronger when it deforms plastically. This process also called as "Cold Working". Based on the strain hardening process, comment on the below process.

a) A cylindrical Brass rod having a minimum tensile strength of 450 MPa, a ductility of at least 13% EL, and a final diameter of 12.7 mm is desired. Some 19mm diameter brass stock that has been cold worked 35% is available. Describe the procedure you would follow to obtain this material. Assume that brass experiences cracking at 65% CW.







b) Perform a brief comparison between the advantages and disadvantages of "Hot working" and "Cold Working" methods.

c) Briefly explain the advantages of forming metals by extrusion as opposed to the rolling method

Electrical properties of materials play a vital role in deciding the Engineering applications of those. Based on that answer the below questions.

d) Define the two types of semiconductor with the aid of diagrams
e) List three engineering applications of semiconductors
f) For intrinsic silicon, the room-temperature electrical conductivity is $8 \times 10^{-4}\ \Omega^{-1}m^{-1}$. The electron and hole mobilities are, 0.24 and 0.064 m^2/Vs respectively. Compute the electron and hole concentrations

$\sigma = E\epsilon$

$\epsilon_A = \{(A_0 - A_f)/ A_{0}\} * 100\%$

$MOR = (3PL) / (2bd^2)$

$\%CW = \{(A_0 - A_d)/A_0)\} * 100\%$

$\sigma_c = \{2E\gamma_s / \pi a\}^{1/2}$

$N(S_a)^m = C$

$P_{LM} = T\,[C + \log (tr)]$

$I = AneV_d$

$\sigma = n|e|\mu_e + p|e|\mu_h$

$E_c(u) = E_m V_m + E_p V_p$

$E_c(l) = E_m E_p / (E_m V_p + E_p V_m)$

$F_c = F_m + F_f$

$\sigma_c A_c = \sigma_m A_m + \sigma_f A_f$

$\sigma_c = \sigma_m V_m + \sigma_f V_f$

$\sigma_c/\epsilon_c = (\sigma_m/\epsilon_m) V_m + (\sigma_f/\epsilon_f) V_f$

$E_c = E_m V_m + E_f V_f$

$E_c = E_m (1-V_f) + E_f V_f$

$I = I_0 e^{-\lambda t}$

$I = I_0 e^{-\mu x}$

$K_c = Y\sigma_c \sqrt{\pi a}$