B.Tech (WINTER SEMESTER) EXAMINATION
(ELECT./MECH./CHEM./ ELECTRONICS/COMPUTER/ARCHITECTURE/PETRO CHEM.
ENGG.)
APPLIED CHEMISTRY (AC-111)

Maximum Marks: 60
Credits: 04
Duration: Two Hours

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

Q.No. 1
(a) Explain the softening of water by Zeolite process. Mention the advantages and dis-
advantages of zeolite process.

(b) Write short notes on any three of the followings:

(i) Sources of water
(ii) Phosphate conditioning
(iii) Boiler corrosion
(iv) Sand bed filtration

(c) What is a disinfectant? Give the requirements of a good disinfectant. Describe the disinfection of water by bleaching powder.

OR

1'(a) Describe the ion exchange process for water softening. Give its advantages over lime-
soda process.

(b) Distinguish between any two of the followings:

(i) Colloidal and carbonate conditioning
(ii) Priming and Foaming
(iii) Temporary and permanent hardness

(c) Calculate the temporary and total hardness of a sample of water in Degree Clarke
(°C) containing following impurities in mg/L: Ca(HCO₃)₂ = 81, Mg(HCO₃)₂ = 36.5,
MgCl₂ = 47.5, CaSO₄ = 136, CaCl₂ = 55.5, Fe₂O₃ = 156, NaCl = 58.5 [At. Wt.: Ca
= 40, Mg = 24, C = 12, H = 1, O = 16, S = 32, Cl = 35.5, Na = 23, Fe = 56]

2(a) What are chemical fuels? Give their classification with example.

(b) Write short notes on any two of the followings:

Contd.....2.
(i) Significance of ultimate analysis
(ii) Advantages of gaseous fuel over liquid fuel
(iii) Synthesis of petrol by Fisher-Tropsch process

(c) Calculate the gross and net calorific value of coal having the following composition of Carbon = 85%, Hydrogen = 8%, Sulphur = 1%, Nitrogen = 2%, Ash = 4%, latent heat of steam = 587 cal/g.

(d) (i) Explain the mechanism of Hydrodynamic lubrication.
(ii) Mention the conditions under which solid lubricants are used.

3(a) Explain the mechanism of dry corrosion? Describe the role of oxide film in dry corrosion.
(b) Describe the effects of any three of the following factors on corrosion rate:
   (i) Passive character of metal
   (ii) Relative areas of anode and cathode
   (iii) Influence of pH
   (iv) Conductance of corroding medium

(c) Explain how corrosion can be controlled by Sacrificial anode method?

4(a) Discuss the mechanism of free radical addition polymerization with example.
(b) Differentiate between any two of the following with suitable example:
   (i) Homo polymer and Co polymers
   (ii) Condensation and Addition polymers
   (iii) Natural and vulcanized rubber

(c) Give the method of preparation, properties and uses of any two of the following polymers:
   (i) Polystyrene (PS)
   (ii) Bakelite
   (iii) Buna-S
2017-18
B.Tech (WINTER SEMESTER) EXAMINATION
(ELECT./MECH./CHEM./ELECTRONICS/COMPUTER/ARCHITECTURE/PETRO CHEM. ENGG.)
APPLIED CHEMISTRY (AC-111)

Maximum Marks: 60  Credits: 04  Duration: Two Hours

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

Q.No.  Question  M.M.
1(a)  Explain the role of lime in softening of water by Lime-Soda process. Mention the [6]

(b)  Write short notes on any three of the followings:
     (i) Impurities in water [3x3]
     (ii) Carbonate conditioning
     (iii) Caustic embrittlement
     (iv) Role of sedimentation in municipal water treatment

OR


(b)  Distinguish between any two of the followings:
     (i) Phosphate and calgon conditioning [2x3]
     (ii) Scale and sludge
     (iii) Break point chlorination and super chlorination

(c)  Calculate the amount of lime (90% pure) and soda (80% pure) required for [5] softening of water containing following impurities in mg/L: Ca(HCO₃)₂ = 40.5, Mg(HCO₃)₂ = 36.5, MgCl₂ = 47.5, CaSO₄ = 136, CaCl₂ = 55.5, Fe₂O₃ = 156, NaCl = 58.5 [At. Wt.: Ca = 40, Mg = 24, C = 12, H = 1, O = 16, S = 32, Cl = 35.5, Na = 23, Fe = 56]

2(a)  What are the advantages of catalytic cracking over thermal cracking?  [3]
b) Write short notes on any two of the followings:
   (i) Significance of proximate analysis
   (ii) Advantages of gaseous fuel over solid fuel
   (iii) Synthesis of petrol by Bergius process

(c) Calculate the gross and net calorific value of coal having the following composition of Carbon = 80%, Hydrogen = 12%, Sulphur = 2%, Nitrogen = 2%, Ash = 4%. Latent heat of steam = 587 cal/g.

(d) (i) Explain the mechanism of extreme pressure lubrication.
    (ii) Mention the conditions under which semi solid lubricants are used.

3(a) What is electrochemical corrosion? Describe the mechanism for rusting of iron in presence of HCl.

(b) Distinguish between any two of the followings:
   (i) Galvanizing and Tinning
   (ii) Sacrificial anode and Impressed current cathodic protection
   (iii) Electrochemical and Galvanic Series

(c) Explain how corrosion can be controlled by design and material selection?

4(a) Describe the extraction and processing of natural rubber from latex.

(b) Differentiate between any two of the followings with suitable example:
   (i) Syndiotactic and atactic polymers
   (ii) Condensation and Addition polymers
   (iii) Thermoplastic and Thermosetting polymers

(c) Give the method of preparation, properties and uses of any two of the following polymers:
   (i) Teflon (PTFE)
   (ii) Polyester
   (iii) Buna-N
2016-17
B.TECH. (WINTER SEMESTER) EXAMINATION
ALL BRANCHES
MATHEMATICS I
AM 112

Maximum Marks: 60
Credits: 04
Duration: Two Hours

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

[CO-1] [07]
1(a) If \( u = \log(x^3 + y^3 + z^3 - 3xyz) \), prove that
\[
\frac{\partial^2 u}{\partial x^2} + \frac{\partial^2 u}{\partial y^2} + \frac{\partial^2 u}{\partial z^2} = -\frac{3}{(x+y+z)^2}.
\]

OR

(a') If \( u \) is a function of two variables \( x \) and \( y \) and \( x = r \cos \theta, y = r \sin \theta \), prove that
\[
\frac{\partial^2 u}{\partial x^2} + \frac{\partial^2 u}{\partial y^2} = \frac{\partial^2 u}{\partial r^2} + \frac{1}{r} \frac{\partial u}{\partial r} + \frac{1}{r^2} \frac{\partial^2 u}{\partial \theta^2}.
\]

[CO-1] [08]
1(b) Prove that the functions \( u = \cos^{-1} x + \sin^{-1} y \) and \( v = x\sqrt{1 - y^2} - y\sqrt{1 - x^2} \) are functionally dependant. Also find the relation between them.

[CO-2] [07]
2(a) Expand \( f(x, y) = e^x \log(1 + y) \) in powers of \( x \) and \( y \) up to third degree terms.

[CO-2] [08]
2(b) Find the dimensions of the rectangular box, open at the top, of maximum capacity whose surface is 432 sq cm.

OR

(b') A balloon is of the form of right circular cylinder of radius 1.5m and length 4m and is surmounted by hemispherical ends. If the radius is increased by 1cm and length by 5 cm. Find the percentage change in the volume of the balloon.

contd... 2
3(a) Show that the volume common to the sphere \( x^2 + y^2 + z^2 = 9 \) and the cylinder \( x^2 + y^2 = 3y \) is \( 6(3\pi - 4) \) cubic units. [CO-3] [07]

3(b) Using triple integral find the volume of the solid bounded below by the paraboloid \( z = x^2 + y^2 \) and above by the plane \( z = 2y \). [CO-3] [08]

(b') By changing to polar coordinates, evaluate \( \iiint xy(x^2 + y^2)^{n/2} \, dx \, dy \) over the positive quadrant of the circle \( x^2 + y^2 = a^2 \), supposing \( n + 3 > 0 \).

Deduce the value of \( \iiint xy(x^2/a^2 + y^2/b^2) \, dx \, dy \) over the positive quadrant of the ellipse \( x^2/a^2 + y^2/b^2 = 1 \).

4(a) Trace the conic
\[ 17x^2 - 12xy + 8y^2 + 46x - 28y + 17 = 0, \]
explaining its main features. Also find the eccentricity and equations of its directrices. [CO-4] [09]

(a') Trace the conic
\[ x^2 - 3xy + y^2 + 10x - 10y + 21 = 0, \]
explaining its main features. Also find the eccentricity and equations of its directrices.

4(b) A circle of given radius passing through the focus \( S \) of a given conic intersects it in \( A, B, C, D \). Show that \( SA, SB, SC, SD \) is constant. [CO-4] [06]
2016-2017
B.TECH. (WINTER SEMESTER) EXAMINATION
(Civil/Chemical/ Computer/ Electrical/ Electronics/ Mechanical//Petro-Chemical)
APPLIED PHYSICS
AP111

Maximum Marks: 60
Credits: 04
Duration: Two Hours

1(a) What do you understand by direct and indirect band gap semiconductors? [8]
Obtain an expression for total current density assuming that electrons and
holes both contribute to the current, hence write electrical conductivity
expression.

OR

1(a') What is Hall effect? Obtain an expression of majority carrier concentration in
terms of measurable parameters for a p-type semiconductor. Mention any two
applications of Hall effect setup.

1(b) What is the physical significance of effective mass? Write an expression for
effective mass and discuss its dependence on band curvature.

1(c) A Si sample is doped with $10^{16}$ cm$^{-3}$ boron atoms and a certain number of
shallow donors. What is donor concentration $N_d$ if Fermi level is 0.36 eV
above $E_F$ at 300 K ?

2(a) Define the terms; induced absorption, spontaneous emission and stimulated
emission. Describe the construction and working of He-Ne laser with the help
of suitable diagrams. What are the advantages of He-Ne laser over ruby laser?

2(b) What is the main advantage of using optical fiber in communication in place
of a conventional system? Obtain an expression of angle of acceptance for a
step index fiber in terms of refractive indices of core and cladding.

2(c) A ruby laser emits 1.0 J pulses of light whose wavelength is 694.3 nm. What
is the minimum number of Cr$^{3+}$ ions in the ruby?

OR

2(c') Find numerical aperture and angle of acceptance of a step index optical fiber
having refractive indices 1.55 and 1.50 of core and cladding respectively.

3(a) Can a wave given by an equation $y=Asin(\omega t-kx)$ represent a particle? Explain
the concept of a wave packet. How does this concept lead to Heisenberg
uncertainty principle?

3(b) Write Schrodinger equation for the particle in a box and solve it to obtain the
eigenfunctions and show that the eigen values are discrete.

OR

............continued to page 2
3(b') A particle having energy $E$ is incident on a finite barrier of height $V_0 (E<V_0)$. Illustrate the wave function in different regions. Find the probability that a particle in a box $L$ wide can be found between $x=0$ and $x=L/n$ when it is in the $n^{th}$ state.

3(c) An electron having energy 1 eV got trapped inside the surface of a metal. If the potential barrier is 4.0 eV and the width of the barrier is 2 Å, calculate the probability of its transmission.

OR

3(c') X-rays are produced by electrons and electrons can be produced by X-rays. Discuss this statement briefly. Find the minimum wavelength present in the radiation from an X-ray machine whose accelerating potential is 20 kV.

4(a) Explain the term Fermi energy. Why the electrons in a metal do not contribute to its specific heat except at very high and very low temperatures?

4(b) At what temperature would one in a thousand of the atoms in a gas of atomic hydrogen be in the $n=2$ energy level?

4(c) Define symmetric and anti symmetric wave function. What differences this makes in the probability $f(n)$ that a particular state of energy $n$ will be occupied.

OR

4(e') How the classical internal energy of solid varies with temperature? Discuss specific heat of solid at constant volume.

**Some useful physical constants**

\[ h = 6.63 \times 10^{-34} \text{ J.s}, \quad k_B = 1.38 \times 10^{-23} \text{ J/K}, \quad m_e = 9.11 \times 10^{-31} \text{ kg}; \]
\[ c = 3 \times 10^8 \text{ m/s}, \quad n_s(Si)=1.5 \times 10^{16} \text{ m}^{-3}, \quad e = 1.6 \times 10^{-19} \text{ C} \]

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2016-17
B.Arch. Even Semester Examination
Constitution & Material I
AR 102
Maximum Marks: 40
Credits: 04
Duration: Two Hours

Present the drawings and sketches to scale with dimensions and specifications.
Assume and write the missing data/situation/dimensions.

1. Sketch and label the following (any two):
   a) Jack Plane
   b) Queen Closer
   c) Brick on End

2. Draw plan, elevation and Isometric view/detail of the following (any two).
   1. One and a half brick thick attached pier to one brick thick wall.
   2. Raking shore for 3 storied building adjoining the construction site.
   3. Timbering of trenches for loose soil.

3. Differentiate between (any 3) of the following given sketches, examples, manufacturing & Continuant details of:
   1. Plywood & Block board.
   2. Vitrified tiles & Terracotta tiles
   3. Veneers & plastic laminate
   4. Stone cladding & Ashlar masonry
Present the graphics with proper colouring and rendering.
Neat presentation of graphics and write-ups with proper examples and sketches carry additional weight-age within maximum marks.

1. Write elaborate and illustrated Notes on any four of the following:
   1. Positive & Negative spaces in Design
   2. Use of certain colours in the interiors of Dining & Banqueting spaces
   3. Painter and there works in the fine arts journey from Impressionism to cubism
   4. Role of additive & subtractive form in 3-D design.
   5. Aesthetics as science & Art of Good design

2. Design, and render (in any medium) a Mural to be executed, on the External wall of the building of Department Of Architecture representing Architectural journey from pre-historic ages to the present architectural scenario at the global level. Present its design to be executed with 1”x1” glossy ceramic beads/tiles on half imperial sheet with half inch margin all around. Use of colours for beads is restricted to 4(+1 for background) only.
2016-17
B.Arch. (Winter Semester) Examination
Architectural Drawing -II
AR 113

Maximum Marks: 40
Credits: 06
Duration: 2 Hours

Answer all the questions.
Assume suitable data if missing.
All dimensions are in mm.
Neat and good drafted drawings will be credited more.

Q.No. | Questions | M.M.
--- | --- | ---
1. | Draw perspective view of the object shown in figure-1 (Eye Level = 40 mm) | 25
2. | Draw siagrapy in front elevation of the object shown in figure -2. (Sun rays are inclined at <45° to ground level in elevation and at <45° to vertical plane in plan) OR | 15
2. | Draw siagrapy in plan of the object shown in figure -2. (Sun rays are inclined at <45° to ground level in elevation and at <45° to vertical plane in plan) | 15

(All dimensions are in mm)
1. Derive anthropometrically the optimum size required for the following spaces showing necessary activities, furniture, required movement areas, etc.
   a) Kitchen
   b) Master Bed Room
   Drawing required to a scale of (1:20)
   i) Plan(s) with furniture / Fixture layout.
   OR

1’ Draw the section of LAVATORY (Male) having anthropometric considerations.

2. Aligarh Muslim University (AMU) is considering to make the campus green, for the very purpose the authority of AMU restricting the vehicular movement and encouraging the cycling and pedestrian movement. To park the cycle in the campus there is a need of cycle stand in almost every department. As an architect, you are requested to design a cycle stand for the campus and that design would be repeated in different department/places in the campus.

Drawings required to a scale of (1:50)

i) Viva

ii) Plan/ Plans

iii) Elevation/ View

(3505)
Q.No.            Question                                      M.M.
1.              What is an ecological succession? What are its different types? [10]

OR

1'.             Define biogeochemical cycle. Write about Carbon cycle and Nitrogen cycle in terms of flow of compounds/nutrients and impact of human activities. [10]

2.              Define Pollutants. Write about Noise pollution and Air pollution in terms of: Causes, Effects and Control measures. [10]

3(a).           Explain the importance and use of mineral resources, give its brief classification and the problems associated with it. [04]

3(b).           Briefly explain the following:
(a) Green revolution
(b) Food problems in India
(c) Adverse impact of modern agriculture
(d) Factors responsible for land degradation
(e) Non-conventional energy resources
(f) Salinity of soil and its significance [06]

4(a).           Write in brief about the nuclear accidents and holocaust. [05]
4(b).           What are the causes for wasteland, how can these be reclaimed? [05]

OR

4'(a).          What is the relation in consumerism and waste products, how can this problem be solved? [05]
4'(b).          What are the functions of central pollution control board and state boards? [05]

5(a).           What is population, its types and growth forms? How population parameters affects its size or density? [05]

OR

5'(a).          Give the names of different components of roof top rain water harvesting system? Write their functions too. [05]
5(b).           In 1900, the population in a country was 350,000. Which grew to 400,000 in 1910. What will be the annual percentage growth for that country? [05]

6(a).           Explain at least 6 vital signs of climate change faced by earth [05]
6(b).           Write notes on any two of the following:
(a) Genetic diversity.
(b) In-situ and ex-situ conservation biodiversity.
(c) Endangered and endemic species of India. [05]
PART A (ELECTRICAL ENGINEERING)

Q.No. | Questions | M.M.
--- | --- | ---
1(a) | Determine the value of current through the 5 Ω resistor as shown in figure 1 by using thavenin theorem. | [07]

![Figure 1](image1.png)

1(a') | Find the current in the 2 Ω resistor as shown in figure 2 by using superposition theorem. | [07]

![Figure 2](image2.png)

1(b) | Describe the principle of operation of single phase transformer. Give a brief description of the core type and shell type transformers. | [08]

2(a) | Describe the principle of operation of three phase induction motor. Discuss the construction of wound rotor type induction motor. | [08]

OR

2(a') | Explain why a single phase induction motor is not self starting. Name different types of single phase induction motors. With the help of circuit diagram describe the working of a shaded pole single phase induction motor. | [08]

2(b) | With the help of suitable diagram explain the operation of a permanent magnet moving coil instrument. | [07]
Q.No.  

1(a) Describe the principle of operation of a bipolar junction transistor. Draw the output characteristic of NPN BJT in the common emitter configuration and describe the various regions of operation from it. (CO-5)  

1(b) Consider the Zener diode regulator shown in Figure 1. Find the load voltage $V_L$ and the source current $I_S$ if $V_{ss}=24V$, $R=1.2k\Omega$ and $R_L=6k\Omega$. (CO-6)  

![Figure 1](image)

1(b') Determine $V_{CE}$ and $I_C$ in the voltage-divider biased transistor circuit shown in Figure 2. Assume $\beta_{DC}=100$ and $I_i \approx I_C$. (CO-6)  

![Figure 2](image)

2(a) Explain the construction and working of n-channel depletion type MOSFET. Also plot the drain characteristic. (CO-6)  

OR  

2(a') Draw an OPAMP based integrator circuit. Derive the formula for its output voltage. Draw the output voltage waveform for square wave and sine wave inputs. (CO-6)  

2(b) Calculate the $V_{OUT}$ for the circuit shown in Figure 3. The given values are: $V_i=2.0$ Volts, $V_2=1.0$ Volts, $V_3=1.5$ Volts, $R_1=R_3=2k\Omega$ and $R_2=R_4=5k\Omega$. (CO-7)  

![Figure 3](image)
UNIT ONE (20 Marks)

1. A) Read the following passage and answer the questions that follow: [5×2=10]

As students of science you are probably sometimes puzzled by the terms ‘pure’ and ‘applied’ science. Are these two totally different activities, having little or no interconnection, as is often applied? Let us begin by examining what is done by each.

Pure science is primarily concerned with the development of theories (or, as they are frequently called, models) establishing relationships between the phenomena of the universe. When they are sufficiently validated, these theories (hypotheses, models) become the working laws or principles of science. In carrying out this work, the pure scientist usually disregards its application to practical affairs, confining his attention to explanations of how and why events occur. Hence, in physics, the equations describing the behavior of fundamental particles, or in biology, the establishment of the life cycle of a particular species of insect living in a Polar environment, are said to be examples of pure science (basic research), having no apparent connection (for the moment) with technology, i.e. applied science.

contd...2
Applied science, on the other hand, is directly concerned with the application of the working laws of pure science to the practical affairs of life, and to increasing man’s control over his environment, thus leading to the development of new techniques, processes and machines. Such activities as investigating the strength and uses of materials, extending the findings of pure mathematics to improve the sampling procedures used in agriculture or in social science, and developing the potentialities of atomic energy, are all examples of the work of the applied scientist or technologist.

i) What is often implied by the terms ‘pure’ and ‘applied’ science?
ii) What is the aim (object) of pure scientific investigation?
iii) What is the work of an applied scientist?
iv) Theories that describe the nature of the universe are constantly revised by scientists. (Replace the underlined with the appropriate ing-form)
v) The synonym of ‘validate’ is
   a) Repeal
   b) Approve
   c) Cancel
   d) Annul

1. B) Write a paragraph summarizing the above passage. [10]

UNIT TWO (10 marks)

2. A) Do you agree with Wells’ view that too much comfort and affluence leads to indolence and laziness and ultimately retards human progress in the light of The Time Machine. [05 Marks]
   
   Or
   
   Discuss the Time travellers’ experiences in the year 802701 AD.

2 B) Write in detail the events leading up to the Battle of the Windmill and its aftermath. [05 Marks]
   
   Or
   
   Discuss Napoleon’s betrayal of the tenets of Animalism.
UNIT THREE

3. Answer any ONE of the following: 10 Marks

Write a report on the recently held Annual Fest in the ZH College of Engineering and Technology at AMU.

Or

Describe the process of applying for an Aadhar Card online.

UNIT FOUR

4. Read the following passage and —
   i) Make notes of the passage [5 Marks]
   ii) Write a Précis of the same [5 Marks]

A few days later, when the terror caused by the executions had died down, some of the animals remembered —or thought they remembered—that the Sixth Commandment decreed “No animal shall kill any other animal.” And though no one cared to mention it in the hearing of the pigs or the dogs, it was felt that the killings which had taken place did not square with this. Clover asked Benjamin to read her the Sixth Commandment, and when Benjamin, as usual, said that he refused to meddle in such matters, she fetched Muriel. Muriel read the Commandment for her. It ran: “No animal shall kill any other animal without cause.” Somehow or other, the last two words had slipped out of the animal’s memory. But they saw now that the Commandment had not been violated; for clearly there was good reason for killing the traitors who had leagued themselves with Snowball.

Through the year the animals worked even harder than they had worked in the previous year. To re build the windmill, with wall twice as thick as before, and to finish it by the appointed date, together with the regular work of the farm, was a tremendous labour. There were times when it seemed to the animals that they worked longer hours and fed no better than they had done in June’s day. On Sunday mornings Squealer, holding down a long strip of paper with his trotter, would read out to them lists of figures proving that the production of every class of foodstuff had increased by two hundred per cent, three hundred per cent, or five hundred percent, as the case might be. The animals saw no reason to disbelieve him, especially as they could no longer remember very clearly what conditions had been like before the Rebellion. All the same, there were days when they felt that they would sooner have had less figures and more food.

UNIT FIVE

5. Write an essay on any ONE of the following in about 300 words. [10 Marks]

WhatsApp is fomenting discord and social anxiety due to absence of censorship.

Or

Diversity is the strength of Indian Democracy.

Or

Automation will destroy human civilization.
2016-17
B.TECH. (WINTER SEMESTER) EXAMINATION
THERMAL SCIENCES
ME-101

Maximum Marks: 60 Credits: 04 Duration: Two Hours

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

Q.No. Question M.M.
1(b) The readings $t_A$ and $t_B$ of two Celsius thermometers, A and B, are agreed at the ice point (0 K) and the steam point (100K), but elsewhere are related by the equation

$$t_A = I + m t_B + n t_B^2$$

where $I$, $m$ and $n$ are constants.

When both thermometers are immersed in a well stirred oil bath, A registers 51 K while B registers 50 K.
(i) Determine the reading on B when A reads 25 K.
(ii) Discuss the question: “Which thermometer is correct?”
1(c) The density of mercury changes approximately linearly with temperature as

$$\rho_m = \left(13595 - 2.5 T\right) \text{kg/m}^3 \text{ (T in Celsius)}$$

so the same pressure difference will result in a manometer reading that is influenced by temperature. If a pressure difference of 100 kPa is measured in the summer at 35°C and in the winter at -15°C, what is the difference in column height between the two measurements?
2(a) Consider a mass going through a polytropic process where pressure is directly proportional to volume \( (n = -1) \). The process starts with \( P = 0, V = 0 \) and ends with \( P = 600 \) kPa, \( V = 0.01 \text{ m}^3 \). Find the boundary work done by the mass.

2(b) The steam supply to an engine comprises two streams which mix before entering the engine. One stream is supplied at the rate of 0.01 kg/s with an enthalpy of \( 2.952 \times 10^6 \) J/kg and the velocity of 20 m/s. The other stream is supplied at the rate of 0.1 kg/s with an enthalpy of \( 2.569 \times 10^6 \) J/kg and a velocity of 120 m/s. At the exit from the engine, the fluid leaves as two streams, one of water at the rate of 0.001 kg/s with an enthalpy of \( 420 \times 10^3 \) J/kg and the other of steam; the fluid velocities at exit are negligible. The engine develops a shaft power of \( 25 \times 10^3 \) W; the heat transfer is negligible. Evaluate the enthalpy of the second exit stream.

OR

2'(b) An indicator spring is found to require an axial force of 60 N to shorten it by 1mm. The spring is used in an indicator having a Piston area of 4 cm² and a pencil mechanism which magnifies the motion of the indicator Piston six fold.

(a) Calculate the spring number in N/m².

(b) A single cylinder, single acting, four stroke gas engine of 150 mm bore develops and indicated power of 4.5 kw when running at 216 rev/min. Calculate the area of the indicator diagram that would be obtained using the above indicator, given that the length of the diagram is 0.1 times the length of stroke of the engine.

3(a) How do we measure the quality of steam of a system using a throttling calorimeter. Show on T-s diagram. Write down the limitations of throttling calorimeter and suggest its solution.

3(b) One kg of steam at 8.5 bar and 0.95 dryness expands adiabatically to a pressure of 1.5 bar. The law of expansion is \( pv^{1.2} = C \). Determine (a) the final dryness fraction of the steam and (b) the change in internal energy.

3(c) Steam initially at 0.3 MPa, 250 °C is cooled at constant volume. (a) At what temperature will the steam become saturated vapor? What is the quality at 80 °C? What is the heat transferred per kg of steam in cooling from 250 °C to 80 °C?

\[ \text{contd...} \]
4(a) What is Perpetual Motion Machine 2 (PMM2)? Why is it impossible? [3]
4(b) Prove that entropy is a property. [4]
4(c) A Carnot heat engine takes in heat from an infinite reservoir A and rejects heat to another infinite reservoir B. Half of the work delivered by this engine is used to drive a generator and another half drives a reversed Carnot engine that receives heat from the reservoir B and rejects heat to an infinite reservoir C. Express the heat rejected to C by the reversed engine as a percentage of the heat supplied from A to the Carnot engine and calculate the heat rejected per hour to C if 500 kW of power is generated. Assume the efficiency of the generator to be 100%.

OR

4'(a) State Kelvin Planck and Clausius statement of the Second Law of Thermodynamics. [3]
4'(b) Define Coefficient of Performance (COP). Show that the COP of heat pump is greater than the COP of refrigerator by unity. [4]
4'(c) The compression ratio in an air-standard Otto cycle is 10. At the beginning of the compression stoke, the pressure is 0.1 MPa and the temperature is 15°C. The heat transfer to the air per cycle is 1800 kJ/kg air. Determine
1. The pressure and temperature at the end of each process of the cycle.
2. The thermal efficiency.
3. The mean effective pressure.

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2016-17
B. TECH. (WINTER SEMESTER) EXAMINATION
ALL BRANCHES
APPLIED MECHANICS
ME-111

Maximum Marks: 60
Credits: 04
Duration: Two Hours

Answer all the questions.
Assume suitable data if missing.
Notations used have their usual meaning.
Programmable calculators (with extra memory storage) are not permitted.
Part A & Part B need to be solved on separate answer books.

Q.No. | Question | Marks
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**PART A**

1(a) Frame $ABCD$ is supported by a ball-and-socket joint at $A$ and by three cables. For $a = 150$ mm, determine the tension in each cable and the reaction at $A$. *(Ref. Fig. 1).*

[Diagram of Frame $ABCD$]

**OR**

1'(a) A wedge $A$ of negligible weight is to be driven between two 100-N plates $B$ and $C$. The coefficient of static friction between all surfaces of contact is 0.35. Determine the magnitude of the force $P$ required to start moving the wedge (a) if the plates are equally free to move, (b) if plate $C$ is securely bolted to the surface. *(Ref. Fig. 2).*

Contd...
1' (b) The slender rod $AB$ is attached to a collar $A$ and rests on a small wheel at $C$. Neglecting the radius of the wheel and the effect of friction, derive an expression for the magnitude of the force $Q$ required to maintain the equilibrium of the rod (Use Principle of Virtual Work). (Ref. Fig. 3).

2(a) A projectile is fired from Point $A$ with an initial velocity $v_0$. (a) Show that the radius of curvature of the trajectory of the projectile reaches its minimum value at the highest Point $B$ of the trajectory. (b) Denoting by $\theta$ the angle formed by the trajectory and the horizontal at a given Point $C$, show that the radius of curvature of the trajectory at $C$ is, $\rho = \rho_{\text{min}} / \cos^3 \theta$. (Ref. Fig. 4).
2(b) A spring is used to stop a 50-kg package which is moving down a 20° incline. The spring has a constant \( k = 30 \text{ kN/m} \) and is held by cables so that it is initially compressed 50 mm. Knowing that the velocity of the package is 2 m/s when it is 8 m from the spring and neglecting friction, determine the maximum additional deformation of the spring in bringing the package to rest. (Ref. Fig. 5).

![Fig. 5](image)

2(b') A bullet is fired with a horizontal velocity of 450 m/s through a 3-kg block \( A \) and becomes embedded in a 2.5-kg block \( B \). Knowing that blocks \( A \) and \( B \) start moving with velocities of 1.5 m/s and 2.7 m/s, respectively, determine (a) the mass of the bullet, (b) its velocity as it travels from block \( A \) to block \( B \). (Ref. Fig. 6).

![Fig. 6](image)

3(a) Arm \( AB \) rotates with an angular velocity of 20 rad/s counterclockwise. Knowing that the outer gear \( C \) is stationary, determine (a) the angular velocity of gear \( B \), (b) the velocity of the gear tooth located at Point \( D \). (Ref. Fig. 7).

![Fig. 7](image)
3(b) Fill in the blanks:

(i) The ball rolls without slipping on the fixed surface as shown below. Draw the figure and mark the direction of the velocity of point A.

(ii) A rectangular plate swings from arms of equal length as shown below. The magnitude of the angular velocity of the plate is .................

(iii) Two pendulums, A and B, with the masses and lengths shown below are released from rest. The system with a larger angular acceleration immediately after release is ..............

(iv) Two solid cylinders, A and B, have the same mass m and the radii 2r and r, respectively. Each is accelerated from rest with a force applied as shown below. In order to impart identical angular accelerations to both cylinders, the relationship between F1 and F2 is ...............
Part B

4(a) A steel bar $ABCD$ is subjected to point loads $P_1$, $P_2$, $P_3$, and $P_4$, as shown in Figure below. The length and diameter of each section is also shown in figure. Calculate the force $P_2$ necessary for equilibrium, if $P_1 = 45$ kN, $P_3 = 20$ kN and $P_4 = 15$ kN. Determine the total elongation of the bar. Take $E = 200$ GN/m$^2$.

![Steel bar diagram]

4(b) At a point in a material under stress, the intensity of the stresses on the plane is shown in figure below. Find:
(a) Resultant stress on the plane $AB$
(b) The principal planes and stresses
(c) The intensity and plane of maximum shear

![Stress diagram]

5(a) Draw the shear force and bending moment diagram for the cantilever beam loaded as shown in figure below.

![Cantilever beam diagram]
5'(a) Draw the shear force and bending moment diagram for the simply supported beam loaded as shown in figure below.

5 kN/m  20 kN  30 kNm
A---------E---------D---------C---------B
 2 m  2 m  2 m  2 m

5(b) A rectangular beam of 400 mm deep and 250 mm wide subjected to uniformly distributed load of 4 kN/m over the entire span. If the maximum stress due to bending is 140 MPa, determine the span of the simply supported beam.