B.TECH/AEIE/CSE/ECE/IT/2ND SEM/ECEN 1001/2017

BASIC ELECTRONICS ENGINEERING
(ECEN 1001)

Time Allotted : 3 hrs **Full Marks : 70**

Figures out of the right margin indicate full marks.

Candidates are required to answer Group A and any 5 (five) from Group B to E, taking at least one from each group.

Candidates are required to give answer in their own words as far as practicable.

Group – A
(Multiple Choice Type Questions)

1. Choose the correct alternative for the following: **10 × 1 = 10**

(i) Avalanche breakdown is primarily dependent on the phenomenon of
(a) collision (b) doping
(c) ionization (d) recombination.

(ii) Band gaps of Si and Ge are respectively
(a) 2 · 2 eV and 1· 2 eV (b) 1·1 eV and 0 · 67 eV
(c) 0 · 67 eV and 1·1 eV (d) 1· 2 eV and 2 · 2 eV.

(iii) An example of uni-polar electronic device is
(a) Diode (b) JFET (c) BJT (d) Varactor diode.

(iv) The current I_{CBO} flows in the
(a) emitter and base leads (b) collector and base leads
(c) emitter and collector leads (d) none of these.

(v) Highest input impedance is obtained in
(a) BJT amplifier (b) JFET amplifier
(c) MOSFET amplifier (d) diode rectifier.

(vi) The effective channel length of a MOSFET in saturation decreases with increase in
(a) gate voltage (b) drain voltage
(c) source voltage (d) body voltage.

(vii) A sinusoidal signal applied to the inverting terminal of an op-amp will experience at the output terminal, a phase shift of
(a) 270° (b) 90° (c) 180° (d) 0°.

(viii) For a step input, the output of an integrator is
(a) a pulse (b) a triangular waveform
(c) a spike (d) a ramp.

(ix) An oscillator whose frequency is changed by a variable dc voltage, is known as
(a) a crystal oscillator (b) a VCO
(c) an Armstrong oscillator (d) a piezoelectric device.

(x) CMOS inverter uses little power because during operation
(a) both MOS are turned on
(b) both MOS are turned off
(c) none of the MOS are turned on
(d) one of the MOS devices is turned on.

Group – B

2. (a) Sketch simple energy band diagram for intrinsic semiconductor at 0 K temperature. Show how the band diagram changes after addition of donor atoms to intrinsic semiconductor and indicate the change of Fermi level. Explain the electrical properties of this kind of materials using band diagrams.

(b) Why the built in barrier voltage in a p-n junction cannot be measured by a voltmeter?

(c) A current of 2 mA flows through a p-type Si bar having a length of 12^ μm and cross-sectional area 100 μm^2 when a voltage of 5 V is applied across the bar. Calculate resistance, resistivity and impurity doping concentration of the sample.

(2 + 2 + 2) + 2 + 4 = 12

3. (a) Explain with a circuit diagram the use of a zener diode as a reference diode.

(b) Explain the operation of a bridge rectifier with the help of a circuit diagram.

(c) The current flowing in a certain p-n junction at room temperature is 2×10^{-7} amp when a large reverse biased voltage is applied. Calculate the current flowing when 0.1 volt is applied.

4 + 5 + 3 = 12

Group – C

4. (a) The metal lead of the p-side of a p-n diode is soldered to the metal lead of the p-side of another p-n diode. Will the structure form an n-p-n transistor? Why?

(b) Explain the operation of NPN transistor in CB configuration with proper circuit diagram. What is early effect?

(c) The collector leakage current in a transistor is $300\,\mu A$ in CE arrangement. If the transistor is now connected in CB arrangement, what will be the leakage current? Given that $\beta = 100$.

2 + (5 + 2) + 3 = 12

5. (a) Derive the relation between α and β for a BJT.

(b) A n-p-n BJT having $\alpha = 0.98$ and reverse saturation current $I_{CO} = 50\ \mu A$ is operating the CB mode. If the base current is $5\ \mu A$, calculate the emitter current and collector current.

(c) Define stability factors. Mention the factors responsible for the stability of Q-point.

3 + 4 + (3 + 2) = 12

Group – D

6. (a) Draw the circuit diagram of a common source n channel JFET amplifier. Discuss its small signal operation.

(b) What is the pinch-off voltage for JFET? Sketch the depletion region before and after pinch-off.

(c) An n-channel Si-JFET has a donor concentration of $6 \times 10^{21}/m^3$ and channel width of 10 μm. If the dielectric constant of Si is 12, find the pinch-off voltage. Find the drain current and saturation voltage V_{Dsat} for V_{GS}= -2V where I_{DSS} = 20 mA, $\varepsilon = 12\varepsilon_0$.

4 + 3 + 5 = 12

7. (a) Explain the difference between enhancement and depletion type MOSFETs.

(b) Explain the basic construction of an enhancement type N-channel MOSFET. Draw and explain its static characteristics.

(c) How is the threshold voltage of MOS-transistor adjusted?

3 + (3 + 3) + 3 = 12

Group – E

8. (a) Define degenerative and regenerative feedback system. What are the possible topologies of a feedback amplifier?

(b) What is Barkhausen criterion for the feedback oscillator?

(c) An amplifier has a gain of 60 and distortion 10% without feedback. Determine (i) gain and (ii) distortion when negative feedback is applied, the feedback factor being 6.

(3 + 2) + 3 + 4 = 12

9. (a) Explain the operation of an OP-AMP differentiator.

(b) Compare the properties of a practical op-amp with those of ideal one.

(c) When a voltage $V_1 = 40\ \mu V$ is applied to the non-inverting input terminal and a voltage $V_2 = -40\ \mu V$ is applied to the inverting input terminal of an OP-AMP, an output voltage $V_0 = 100$ mV is obtained. But when $V_1 = V_2 = 40\ \mu V$, one obtains $V_0 = 0.4$ mV. Calculate the voltage gains for the difference and the common-mode signals, and the common mode rejection ratio.

3 + 3 + 5 = 12

B.TECH/AEIE/BT/CE/CHE/CSE/ECE/EE/IT/ME/2ND SEM/CSEN 1201/2017

INTRODUCTION TO COMPUTING
(CSEN 1201)

Time Allotted : 3 hrs **Full Marks : 70**

Figures out of the right margin indicate full marks.

Candidates are required to answer Group A and any 5 (five) from Group B to E, taking at least one from each group.

Candidates are required to give answer in their own words as far as practicable.

Group – A
(Multiple Choice Type Questions)

1. Choose the correct alternative for the following: **10 × 1 = 10**

(i) What will be the standard SOP expression for the following table?

Inputs			Output
A	B	C	X
0	0	0	0
0	0	1	1
0	1	0	0
0	1	1	1
1	0	0	0
1	0	1	0
1	1	0	1
1	1	1	0

A'B'C
A'BC
ABC

(a) $X = \bar{A}\bar{B}\bar{C} + ABC + A\bar{B}C$ (b) $X = ABC + ABC + ABC$

(c) $X = A\bar{B}C + \bar{A}BC + AB\bar{C}$ (d) $X = \bar{A}\bar{B}C + \bar{A}BC + AB\bar{C}$

(ii) What would be the output of the following code snippet?

```
int main(void)
    {
        const int a = 10;
        int *p = &a;
        *p = 20;
        printf("%d", a);
        return 0;
    }
```

(a) Compilation error (b) 10

(c) 20 (d) None of the above.

(iii) What is the default return type of functions?

(a) int (b) char (c) float (d) double.

(iv) What would be the output of the following code snippet?

```
int main(void)
{
    int a = 10;
    float b = 2.5;
    if(b = 0)
    {
            printf("%d ",printf("%d",b));
    }
    else
    {
            printf("%d ",printf("%d",b));
    }
    return 0;
}
```

(a) 0 1 (b) 1 0 (c) 2 1 (d) 1 2

(v) Assume a 2-d array has been declared and initialized as follows:
int x[3][5] = { {1,2,3;4,5} , {6,7,8,9,10}, {11,12,13,14,15} };
Which of the following is incorrect statement?
(a) printf("%d",*(*(x+2)+1)); prints 12
(b) printf("%d",*(*(x+1))); prints 6
(c) printf("%d",*(*(x)+2)+1); prints 5
(d) printf("%d",*(*(x+1)+3); prints 9.

(vi) A -> B is syntactically correct if
(a) a and b are structure
(b) a is a structure and b is a pointer to structure
(c) a is a pointer to structure and b is a structure
(d) a is a pointer to structure in which b is a field of the structure.

(vii) Select the fastest memory unit
(a) Register (b) Cache
(c) RAM (d) Hard disk.

(viii) In which part of the program compilation process macros are dealt with?
(a) Assembly (b) Pre-processing
(c) Linking (d) None of the above.

(ix) Meaning of x >> 3 is same as,
(a) x / 3 (b) x * 8 (c) x * 3 (d) x / 8.

(x) What will be the output of the following code snippet?

```
#define SQUARE(X) X * X
int main ( )
    {
        printf ("\n Square = %d" , SQUARE(10+2) );
        return 0;
    }
```

(a) 144 (b) 32 (c) 122 (d) 12.

Group – B

2. (a) Draw a flowchart to check whether a number is prime or not.

(b) Convert from one number system to the other:
(i) $(29.65)_{10} = (?)_2$ (ii) $(364364364)_8 = (?)_{16}$

(c) Simply the expression: $AB + A(B + C) + B(B + C)$

5 + (2 × 2) + 3 = 12

3. (a) What will be 32-bit full precision floating representation for 24.75?

(b) State the differences between compiler and interpreter.

(c) What is a universal logic gate?

(d) Draw a logic circuit to simulate an XOR gate by using only NOR gates. (Minimum number of NOR gates should be used)

6 + 2 + 1 + 4 = 12

Group – C

4. (a) Write a program to check whether a number is a palindrome or not, without using array.

(b) Explain explicit and implicit type casting with an example. How would you use these techniques to round off a floating point number?

6 + (4 + 2) = 12

5. (a) Write a C program to print this pattern, where the number of rows will be taken as an input from the user.

```
*
**
***
****
*****
```

(b) Explain the output (error) of the following code snippets:

(i)
```
int main ( )
{
double degC, degF = 96;
degC = 5/9 * (degF - 32);
printf ("%f", degC);
return 0;
}
```

(ii)
```
int main ( )
{
int x = 0, y = 2, z = -1;
x = x && y || z;
printf ("%d", x);
x = y = z = -1;
++x || ++y && ++z;
printf ("%d%d%d", x, y, z);
return 0;
}
```

(iii)
```
int main ( )
{
const int num = 20;
float x = 10.7356;
num+ = num;
printf ("%d", num);
printf ("%0.0f %8.2f", x, x);
return 0;
}
```

(iv)
```
int main ( )
{
int loop;
for(loop = 15; loop >= 0; loop--)
{
if( (1 << loop) & n)
printf("1");
else
printf("0");
}
return 0;
}
```

Group – D

6. (a) Write a function ceil( ) with prototype int ceil(float), so that it converts a floating point number into the smallest integer which is not less than the number. Example: ceil(1.02) will return 2.00 and ceil(-1.02) will return -1.00.

(b) Write a C program to reverse any number using recursion.

(c) How does a local static variable behave differently from a local variable in a function?

4 + 6 + 2 = 12

7. (a) Write a program that defines SCUBE(a, b), a macro, as $a^3 + b^3$ and test the program to find SCUBE (4, 5 + 6).

(b) Write a program that multiplies two matrices of dimensions m × n and p × q, using a function.

5 + 7 = 12

Group – E

8. (a) Write a program to merge two numbers using pointers so that the new number is constructed by sequentially putting the digits of the first number as the odd digits in the new number and the digits of the second number as the even digits of the new number. Example: 123 and 456 will be merged to create 142536.

(b) Write a program that takes two strings as command line arguments and compares them to see whether they are same or not. (Do not use any function from string.h library)

6 + 6 = 12

9. (a) State the difference between malloc() and calloc(). Write a C programme to perform matrix multiplication using dynamic memory allocation. (Do not forget to free your used memory)

(b) Write a C program which will take a file name as a command line input and search that file in the current working directory. It will print "SUCCESS" if the file is present in the current working directory else it will print "FAILURE".

(2 + 6) + 4 = 12

× 2) = 12

123456

PHYSICS - I
(PHYS 1001)

Time Allotted : 3 hrs **Full Marks : 70**

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Candidates are required to answer Group A and any 5 (five) from Group B to E, taking at least one from each group.

Candidates are required to give answer in their own words as far as practicable.

Group – A
(Multiple Choice Type Questions)

1. Choose the correct alternative for the following: **10 × 1 = 10**

(i) Missing orders are found in case of double slit diffraction pattern due to
(a) unequal value of two slit widths
(b) superposition of diffraction maxima and interference minima
(c) superposition of diffraction minima and interference maxima
(d) oblique incidence of light.

(ii) Two mutually perpendicular S.H.M. with equal time periods but different amplitudes are superimposed. If the phase difference between these oscillations is 45^0, then they form a
(a) circle (b) parabola (c) straight line (d) ellipse.

(iii) The nearest neighbour distance of a simple cubic crystal of unit cell length 'a' is
(a) $\frac{a}{2}$ (b) a (c) $2a$ (d) $\frac{3a}{2}$.

(iv) De Broglie wavelength of a particle with mass m and kinetic energy E for non-relativistic case is
(a) $\lambda = \sqrt{\frac{2mE}{h}}$ (b) $\lambda = \sqrt{2mE}$ (c) $\lambda = \frac{h}{\sqrt{2mE}}$ (d) $\lambda = 0$.

(v) If in Newton's ring experiment the air film is replaced by oil then the radius of the rings of same order will
(a) increase (b) decrease
(c) remain same (d) none of these.

(vi) Which of the following is a biaxial crystal?
(a) Calcite (b) Quartz (c) Argonite (d) None of these.

(vii) The coordination number in FCC lattice is,
(a) 12 (b) 4 (c) 8 (d) 6.

(viii) The resonant frequency of an electrical oscillator (L-C-R) is given by,
(a) $\nu = 2\pi\sqrt{LC}$ (b) $\nu = \frac{1}{2\pi\sqrt{LC}}$ (c) $\nu = \frac{2\pi}{\sqrt{LC}}$ (d) $\nu = 2\pi\sqrt{\frac{L}{C}}$

(ix) Relative velocities of two photons moving in vacuum with velocity 'c' in opposite direction is,
(a) c (b) zero (c) 2c (d) all of them.

(x) Compton shift $\Delta\lambda$ and Compton wave length λ_c are equal if the angle of scattering is
(a) 0^0 (b) 90^0 (c) 180^0 (d) 360^0.

Group – B

2. (a) Find the expression of fringe width in case of Young's double slit interference pattern.

(b) Newton's rings are obtained in reflected light of wavelength 5900Å. The diameter of the 10th dark ring is 0.5 cm. Find the radius of curvature of the lens (R) and the thickness of the air film corresponding to 10th dark ring (t).

(c) Find the state of polarization when x and y components of the electric field are, $E_x = E_0 \cos(\omega t + kz)$ and $E_y = (E_0/\sqrt{2}) \cos(\omega t + kz + \pi)$.

(d) What do you mean by spontaneous and stimulated emission of a radiation?

5 + (2 + 1) + 2 + 2 = 12

3. (a) A plane polarized light of wavelength 5893Å is incident on a thin quartz plate cut with faces parallel to the optic axis. Calculate the minimum thickness of the retardation plate for which the O-ray and E-ray waves will combine to produce circularly polarized light. [Given that, $\mu_e = 1.553$ and $\mu_o = 1.544$].

(b) Write a short note on positive and negative crystal.

(c) A monochromatic light of wavelength 5500Å is incident on a single slit of width 0.3 mm and gets diffracted. Find the diffraction angles for the 1st and the 2nd minima.

(d) Explain briefly the basic operational principle of Optical Fibre and mention any two applications of it.

3 + 3 + 3 + (2 + 1) = 12

Group – C

4. (a) The potential energy of a particle of mass 'm' is given by $\frac{1}{2}m\omega^2x^2$, where ω is a constant. Show that the particle is executing a simple harmonic motion.

(b) If $Y = A\cos(\omega t - kx)$ represents a harmonic wave, establish the differential equation for the wave propagation and find its velocity of propagation.

(c) A particle is simultaneously under two simple harmonic motions at right angles to each other, represented by $x = a\sin\omega t$, $y = b\sin(\omega t + \delta)$.
(i) Show that the resultant motion is represented by

$$\frac{x^2}{a^2} + \frac{y^2}{b^2} - \frac{2xy}{ab}\cos\delta = \sin^2\delta.$$

(ii) What will be the trajectory of the particle when $\delta = \pi/2$ and $a = b$?

3 + (2 + 1) + (4 + 2) = 12

5. (a) A particle is subjected to a linear restoring force and damping (proportional to velocity). Write down the differential equation of motion explaining each term.

(b) Solve the equation for weak damping and prove that the amplitude of vibration decreases exponentially with time.

(c) Show that for weakly damped motion, the logarithm of the ratio of successive amplitudes on the same side above the mean position is constant.

(d) A vibrator of mass 1 gm is acted upon by a restoring force of 10^7dyne/cm of displacement, a retarding force of 4×10^3 dyne/velocity and a driving force $10^5\cos(t)$ dyne. Find the value of the amplitude at steady state and the quality factor.

2 + (3 + 2) + 2 + 3 = 12

Group – D

6. (a) Write down the energy and momentum conservation equation in Compton effect. Through what angle must a 0.20 MeV photon be scattered by a free electron so that it loses 10% of its energy?

(b) What is the origin of modified and unmodified line in Compton effect?

(c) Write down the Planck's radiation law for blackbody explaining all terms. Using it, show that the wave length at which we get maximum radiation density per unit volume per unit time is inversely proportional to the absolute temperature of it.

(2 + 3) + 2 + (2 + 3) = 12

7. (a) State Heisenberg's uncertainty principle explaining each terms.

(b) State and explain de Broglie's hypothesis. Show that the relativistic de Broglie's wave length is given by $\lambda_{relativistic} = \frac{h}{\sqrt{E_k(E_k + 2m_0c^2)}}$, the notations have their usual meaning.

(c) A particle has a kinetic energy 20 times of its rest energy. Find the speed of the particle in terms of velocity of light in vacuum (c).

(d) Show that the rest mass m_0 of a particle of momentum P and kinetic energy "T" are related by $m_0 = \frac{P^2c^2 - T^2}{2Tc^2}$ (c = velocity of light in vacuum).

2 + (2 + 3) + 2 + 3 = 12

Group – E

8. (a) Find the relation between the atomic radius and the lattice constant for a Body centred cubic crystal and Face centred cubic crystal.

(b) Derive Bragg's law related to X-ray diffraction from crystal planes.

(c) A beam of *X*-rays of wavelength 0.842Å is incident on a crystal at a glancing angle $8^0 5'$, when first order Bragg's reflection occurs. Calculate the glancing angle for third order reflection.

(d) Within a cubic unit cell, sketch the following directions: $[1\bar{1}1]$ and [010].

(2 + 2) + 3 + 3 + (1 + 1) = 12

9. (a) Explain Miller indices.

(b) Calculate the Miller indices of a plane with intercepts a/2, b, 3c and hence find the inter-planar spacing (where a, b, c have their usual meanings).

(c) What is co-ordination number? Show that atomic packing factor increases with co-ordination number.

(d) The atomic diameter of an atom of iron (BCC) is 0.2482 nm and atomic weight is 55.85 kg/kmol. Calculate the lattice constant.

2 + (2 + 2) + (1 + 3) + 2 = 12

B.TECH/AEIE/BT/CE/CHE/CSE/ECE/EE/IT/ME/2ND SEM/MECH 1201/2017

ENGINEERING THERMODYNAMICS AND FLUID MECHANICS
(MECH 1201)

Time Allotted : 3 hrs Full Marks : 70

Figures out of the right margin indicate full marks.

Candidates are required to answer Group A and any 5 (five) from Group B to E, taking at least one from each group.

Candidates are required to give answer in their own words as far as practicable.

Group – A
(Multiple Choice Type Questions)

1. Choose the correct alternative for the following: $10 \times 1 = 10$

(i) As differentials, heat transfer and work transfer can be described mathematically as
(a) inexact (b) exact
(c) point function (d) discontinuity.

(ii) A thermodynamic system is referred to be an isolated system when there is transfer of _____ across the system boundaries
(a) only mass (b) only energy
(c) both mass and energy (d) neither mass nor energy.

(iii) Heat transferred to a closed stationary system at constant volume equals to
(a) increase in enthalpy (b) increase in internal energy
(c) increase in entropy (d) none of these.

(iv) A reversible adiabatic process on T–S diagram is represented by
(a) horizontal line (b) curved line
(c) vertical line (d) inclined line.

(v) Which parameter can be considered to remain constant if the value of the exponent n in the polytropic equation pv^n = constant takes a unit value for an ideal gas in a quasi-static expansion?
(a) enthalpy (b) entropy
(c) internal energy (d) pressure or volume.

(vi) In a Carnot cycle, the addition and rejection of heat take place at constant
(a) pressure (b) volume (c) temperature (d) enthalpy.

(vii) The piezometric head in a static liquid
(a) remains constant only on a horizontal plane
(b) increases linearly with depth below a free surface
(c) remains constant at all points in the liquid
(d) decreases linearly with depth below a free surface.

(viii) Which fluid does not experience shear stress during flow?
(a) Pseudoplastic (b) Dilatant
(c) Inviscid (d) Newtonian.

(ix) Newton's law of viscosity relates to
(a) angular deformation, velocity and viscosity
(b) shear stress and rate of angular deformation
(c) shear stress, temperature, viscosity and velocity
(d) pressure, viscosity and rate of angular deformation.

(x) The continuity equation is based on principle of conservation of
(a) mass (b) energy
(c) momentum (d) force.

Group – B

2. (a) One kg of a certain fluid is contained in a horizontal cylinder fitted with a frictionless leak proof piston at a pressure of 10 bar. The fluid is allowed to expand reversibly in the cylinder until the volume becomes two times its original volume. During the expansion process, the relation between pressure and volume is given by pv^2 = constant. The fluid is then cooled reversibly at constant pressure until the piston regains its original position. Finally the fluid is heated reversibly with the piston firmly locked in position and the fluid pressure rises to initial value of 10 bar. If the fluid has an initial volume of 0.05 m^3, make calculations for the net work done by the fluid.

(b) Define specific heat at constant volume and constant pressure. Explain what is meant by a quasi-static process.

7 + (3 + 2) = 12

3. (a) A stationary mass of gas is compressed reversibly from an initial state (0.4m^3, 0.1MPa) to a final state (0.2m^3, 0.1MPa); the pressure remaining constant during the process. If there is a transfer of 15 kJ of heat from the gas during the process, evaluate the change in internal energy of the gas.

(b) Explain what is meant by a thermodynamic system and classify different thermodynamic systems. Define a PMM1. What is the converse of a PMM1?

6 + (4 + 2) = 12

Group – C

4. (a) Steam flows steadily into a condenser and at entry it has an enthalpy of 2050 kJ/kg and velocity of 500 m/s. The condensate (condensed steam) leaves with an enthalpy of 200 kJ/kg and velocity of 10 m/s. The exit from the condenser is in line with the inlet. Determine the heat transfer to the cooling water per unit mass of steam.

(b) State Kelvin Planck statement of the second law of Thermodynamics and hence explain what is meant by a PMM2. Make an energy analysis of a steam turbine as a steady flow energy device.

6 + (3 + 3) = 12

5. (a) (i) What is the difference between a refrigerator and a heat pump?
(ii) What is entropy principle?

(b) A heat engine operating between two reservoirs at 1000 K and 300 K is used to drive a heat pump which extracts heat from the reservoir at 300 K at a rate twice that at which the engine rejects heat to it. If the efficiency of the engine is 40% of the maximum possible and the COP of the heat pump is 50% of the maximum possible,
(i) What is the temperature of the reservoir to which the heat pump rejects heat?
(ii) What is the rate of heat rejection from the heat pump if the rate of heat supply to the engine is 50 kW?

(2 + 2) + (5 + 3) = 12

Group – D

6. (a) Distinguish between
(i) Compressible and Incompressible fluid
(ii) Gauge pressure and Vacuum pressure.

(b) A hydraulic ram, having 200mm diameter and 1.2m long moves within a concentric cylinder 200.2mm diameter. The annular clearance is filled with oil of specific gravity 0.85 and kinematic viscosity 400mm²/s. What is the power required to move the ram at a speed of 120mm/s?

(2 + 2) + 8 = 12

7. (a) An ideal Diesel cycle with air as the working fluid has a compression ratio of 18 and cut-off ratio of 2. At the beginning of compression process, the working fluid is at 100 kPa, 27°C, and 1917 cm^3. Determine (i) the temperature and pressure of air at the end of each process, (ii) the net work output in kJ (iii) the thermal efficiency of the cycle.
For air, c_p=1.005 kJ/kg-K; c_v = 0.718 kJ/kg-K; γ =1.4; R= 0.287 kJ/kg-K.

(b) A closed tank contains 0.5m of mercury (specific gravity 13.6) at bottom, above which there are 2 m of water, 3 m of oil of specific gravity 0.6 and there is air space above the oil at the top part, inside the tank. If the gauge pressure at the bottom of the tank is 196.2 kPa, what is the pressure of the air at the top part of the tank?

(6 + 1 + 1) + 4 = 12

Group – E

8. (a) Oil of specific gravity 0.9 and viscosity 2.5 Poise flows through a 100mm diameter pipe, 500m long at a rate of 2 litre/sec. Find the Reynolds number of the flow.

(b) Two small closed vessels are connected to a U-tube manometer containing mercury (relative density 13.56) and the connecting tubes are filled with oil (relative density 0.82). The vessel at the higher pressure is 2m lower in elevation than the other.
(i) What is the pressure difference between the vessels when the steady difference between mercury meniscus is 225mm?
(ii) What is the difference of piezometric head between manometer connection points?
(iii) If an inverted U-tube manometer containing a liquid of relative density of 0.74 were used instead, what would be the manometer reading for the same pressure difference?

4 + (3 + 2 + 3) = 12

9. (a) Water flows up a vertical venturimeter whose inlet and throat diameters are 250 mm and 125 mm respectively, the throat section being 0.30 m above the inlet section. The pressure at the inlet and the throat sections are 60 kPa and 20 kPa respectively. Find the rate of flow through the meter. Take C_d = 0.98.

(b) Differentiate between steady and uniform flow with example. What is turbulent flow? Write the expression of Reynolds number and specify the range of values for laminar and turbulent flow through a pipe.

6 + (3 + 3) = 12

MATHEMATICS - II
(MATH 1201)

Time Allotted : 3 hrs **Full Marks : 70**

Figures out of the right margin indicate full marks.

Candidates are required to answer Group A and any 5 (five) from Group B to E, taking at least one from each group.

Candidates are required to give answer in their own words as far as practicable.

Group – A
(Multiple Choice Type Questions)

1. Choose the correct alternative for the following: **10 × 1 = 10**

(i) $\frac{1}{D^2+1}\sin 2x =$

(a) $\frac{1}{3}\sin 2x$ (b) $\frac{1}{3}\cos 2x$ (c) $-\frac{1}{3}\sin 2x$ (d) $\frac{1}{5}\sin 2x$

(ii) The general solution of $\frac{d^2y}{dx^2} = 0$ is

(a) $y = a$ (b) $y = ax + b$

(c) $y = ax^2 + bx + c$ (d) $y = a\cos x + b\sin x$.

(where a, b, c are arbitrary constants).

(iii) Integrating factor of $x\frac{dy}{dx} + y = xe^x$ is

(a) x (b) e^x (c) 1 (d) e^{-x}.

(iv) The minimum number of edges in a connected graph having 21 vertices is

(a) 18 (b) 20 (c) 10 (d) 11.

(v) The number of pendant vertices in a binary tree with n vertices is

(a) n-1 (b) n (c) n+1 (d) (n+1)/2.

(vi) $L\{e^{-t}\sin 2t\} =$

(a) $\frac{1}{s^2+2s+5}$ (b) $\frac{2}{s^2+2s+5}$

(c) $\frac{s}{s^2+2s+5}$ (d) $\frac{s+1}{s^2+2s+5}$.

(vii) $L^{-1}\left\{\frac{1}{(p+1)(p+3)}\right\} =$

(a) $\frac{1}{2}(e^{t}-e^{3t})$ (b) $(e^{-t}-e^{-3t})$ (c) $\frac{1}{2}(e^{-t}-e^{-3t})$ (d) $\frac{1}{2}(e^{-3t}-e^{-t})$.

(viii) $\Gamma(7/2)$ is equal to

(a) $\frac{5\sqrt{\pi}}{8}$ (b) $\frac{3\sqrt{\pi}}{4}$ (c) $\frac{15\sqrt{\pi}}{8}$ (d) $\frac{\sqrt{\pi}}{2}$.

(ix) A directed line makes angles 60° and 45° with the axes of x and y respectively. What angle does it make with the axis of z?

(a) 60° (b) 45° (c) 30° (d) 90°.

(x) The length of the perpendicular from the origin upon the plane $2x+6y-3z+5=0$ is

(a) 5/7 (b) 6/7 (c) 3/7 (d) 5.

Group – B

2. (a) The equation $\frac{x^2}{a^2+\lambda}+\frac{y^2}{b^2+\lambda}=1$ (where a and b are fixed constants and λ is an arbitrary parameter which can assume all real values) represents a family of confocal conics. Obtain the differential equation of this family.

(b) Determine the exactness of the following differential equation:

$$\left\{y\left(1+\frac{1}{x}\right)+\cos y\right\}dx+\left(x+\log x-x\sin y\right)dy=0$$

(c) Solve: $e^{y}-p^{3}-p=0$

4 + 2 + 6 = 12

3. (a) Solve: $x^2\frac{d^2y}{dx^2}-x\frac{dy}{dx}+4y=x\sin(\log x)$

(b) Solve the following differential equation using the method of variation of parameters:

$$\frac{d^2y}{dx^2}-y=\frac{2}{1+e^{x}}$$

6 + 6 = 12

Group – C

4. (a) What will be the least possible number of simple regular graphs having 20 edges? Justify your answer.

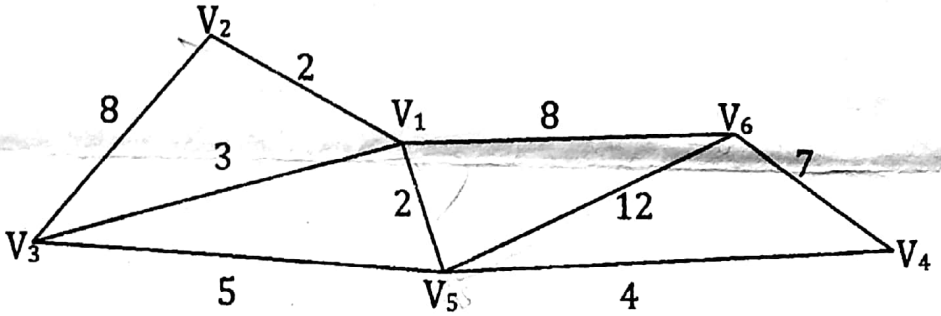
(b) Draw the digraph with the following adjacency matrix:

$$\begin{pmatrix} 0 & 0 & 1 & 1 & 0 \\ 1 & 1 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 1 \\ 0 & 0 & 0 & 0 & 0 \\ 0 & 1 & 1 & 0 & 0 \end{pmatrix}$$

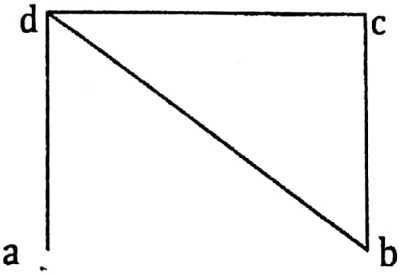
(c) Let G be a graph with 15 vertices and 4 components. Prove that, G has at least one component having at least 4 vertices.

5 + 4 + 3 = 12

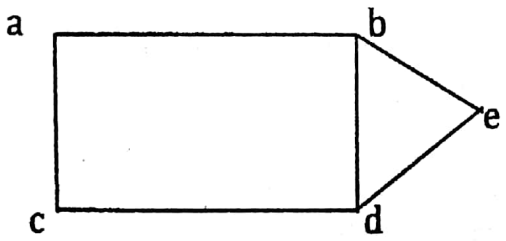
5. (a) Use Kruskal's algorithm to find a minimal spanning tree for the following graph:



(b) Find and hence draw all possible spanning trees in the following graph:



(c) Using BFS and DFS algorithms, find spanning trees of the following graph:



4 + 3 + 5 = 12

Group – D

6. (a) Evaluate $\int_{-\infty}^{\infty} \frac{dx}{x^2 + 2x + 2}$, if it exists.

(b) Assuming the convergence of the integral prove that, $\int_0^{\infty} \sqrt{x} e^{-x^3} dx = \frac{\sqrt{\pi}}{3}$.

6 + 6 = 12

7. (a) Evaluate: $L^{-1}\left\{\log\left(\frac{s+a}{s+b}\right)\right\}$

(b) Solve by Laplace Transform:
$y''(t) + y(t) = \sin 2t$, where $y(0) = y'(0) = 1$.

6 + 6 = 12

Group – E

8. (a) Show that the straight lines whose direction cosines are given by $al + bm + cn = 0$ and $ul^2 + vm^2 + wn^2 = 0$ are parallel if $\frac{a^2}{u} + \frac{b^2}{v} + \frac{c^2}{w} = 0$.

(b) A variable plane at a constant distance p from the origin 0 meets the axes at A, B, C. Show that the locus of the centroid of the tetrahedron OABC is $\frac{1}{x^2} + \frac{1}{y^2} + \frac{1}{z^2} = \frac{16}{p^2}$.

6 + 6 = 12

9. (a) Find the equations of the lines of greatest slope and least slope on the plane $3x - 4y + 5z - 5 = 0$ drawn through the point (1, 2, 2), given that the plane $4x - 5y + 6z - 6 = 0$ is horizontal.

(b) Show that the equation to the plane containing the line $\frac{y}{b} + \frac{z}{c} = 1, x = 0$ and parallel to the line $\frac{x}{a} - \frac{z}{c} = 1, y = 0$ is $\frac{x}{a} - \frac{y}{b} - \frac{z}{c} + 1 = 0$ and if $2d$ is the shortest distance, prove that $\frac{1}{d^2} = \frac{1}{a^2} + \frac{1}{b^2} + \frac{1}{c^2}$.

6 + 6 = 12