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SECOND SEMESTER B.TECH. (COMMON TO ALL BRANCHES)

END SEMESTER EXAMINATIONS, APRIL 2018

SUBJECT: ENGINEERING MATHEMATICS-II[MAT 1201]

REVISED CREDIT SYSTEM

16/04/2018

Time: 3 Hours MAX. MARKS: 50

Instructions to Candidates:

- Answer **ALL** the questions.
- Missing data may be suitably assumed.

1A.	Expand f(x, y) = sinxy in powers of $x-1$ and $y-{}^{\pi}/_{2}$ up to third degree terms.	**3M**
1B.	The period T of a simple pendulum is $T=2\pi\sqrt{\frac{l}{g}}$. Find the maximum error in T due to possible errors upto 1 % in l and 2 % in g.	**3M**
1C.	Find the volume of paraboloid of revolution $x^2+y^2=4z$ cut off by the plane z = 4.	**4M**
2A.	Find the extreme values of the function $f(x,y)=xy(a-x-y)$	**3M**
2B.	Find the area included between the cardioids $r=a(1+cos\theta)$ and $r=a(1-cos\theta)$.	**3M**
2C.	Solve $y''+5y'+6y=e^{-2t}$ given $y(0)=y'(0)=1$ by using Laplace transform.	**4M**
3A.	Evaluate (i) $\lim_{x\to 0}\frac{xe^x-\log(1+x)}{x^2}$ (ii) $\lim_{x\to 0}(1+\sin x)^{\cot x}$.	**3M**
3B.	Find the nature of the series $\frac{1}{1^2}+\frac{1+2}{1^2+2^2}+\frac{1+2+3}{1^2+2^2+3^2}+\ldots$	**3M**

3C.	Find the Laplace transform of *i*) $\left\{\frac{1-cost}{t}\right\}$ ii) $\int_0^t t\ e^{-t}\ sin4t\ dt$	**4M**
4A.	Change the order of integration and evaluate $\int_0^1 \int_{\sqrt{y}}^{2-y} xy\ dxdy$	**3M**
4B.	If $u = \log_e\left[\frac{x^4+y^4}{x+y}\right]$ then find the value of $x\frac{\partial u}{\partial x} + y\frac{\partial u}{\partial y}$.	**3M**
4C.	Find $L^{-1}\left[\frac{3}{s} - 4\frac{e^{-s}}{s^2} + 4\frac{e^{-3s}}{s^2}\right]$ and sketch the graph of the function of t.	**4M**
5A.	Find the equation of a sphere whose great circle is $x^2 + y^2 + z^2 + 10y - 4z = 8$, $x + y + z = 3$.	**3M**
5B.	Prove that $\beta(m,n) = \frac{\Gamma m\ \Gamma n}{\Gamma(m+n)}$.	**3M**
5C.	Test the nature of the series $x - \frac{x^2}{2} + \frac{x^3}{3} - \frac{x^4}{4} + \frac{x^5}{5} - \cdots$.	**4M**

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II SEMESTER B.TECH.

END SEMESTER EXAMINATIONS, April 2019

SUBJECT: ENGINEERING MATHEMATICS-II [MAT 1251]

REVISED CREDIT SYSTEM

Time: 3 Hours Date: 23-04-2019 MAX. MARKS: 50

Instructions to Candidates:

- Answer **ALL** the questions.

1A.	a) Evaluate $\lim_{x\to 0}\left(\frac{\text{Sin x}}{x}\right)^{1/x^2}$ b) Evaluate $\lim_{x\to 0}\left(\frac{1}{x}-\frac{1}{e^x-1}\right)$	**4**
1B.	If $f(x)=\sin^{-1}x, 0<a<b<1$, then use mean value theorem to prove $\frac{b-a}{\sqrt{1-a^2}}<\sin^{-1}b-\sin^{-1}a<\frac{b-a}{\sqrt{1-b^2}}$.	**3**
1C.	If $u=\sin^{-1}\left(\frac{x^2+y^2}{x+y}\right)$, then show that $x^2\frac{\partial^2 u}{\partial x^2}+2xy\frac{\partial^2 u}{\partial x\partial y}+y^2\frac{\partial^2 u}{\partial y^2}=\tan^3 u$.	**3**
2A.	Expand $f(x,y)=e^x\sin y$ about the point $\left(0,\frac{\pi}{2}\right)$ up to third degree terms.	**4**
2B.	Find the maximum and minimum distance from the point $(1,2,3)$ to the sphere $x^2+y^2+z^2=36$.	**3**
2C.	Find the equation of the sphere which passes through the circle $x^2+y^2+z^2-2x-3y+4z+8=0, x-2y+z-8=0$ and has the center on the plane $4x-5y-z-3=0$.	**3**

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3A.	Test the convergence of the following series a) $\frac{4}{18}+\frac{4\cdot12}{18\cdot27}+\frac{4\cdot12\cdot20}{18\cdot27.36}+\cdots\infty$ b) $\sum_{n=1}^{\infty} ne^{-n^2}$	**4**
3B.	Evaluate $\int_0^{\pi/2}(\sqrt{tan\theta}-\sqrt{sec\theta})d\theta$	**3**
3C.	Find the area bounded by the curves $r=a(1+cos\theta)$ and $r=a\,(1-cos\theta)$.	**3**
4A.	a) Find $L\left[\frac{e^t\sin t}{t}\right]$ b) Find $L^{-1}\left[\frac{s^2+s-2}{s(s+3)(s-2)}\right]$	**4**
4B.	Solve $y''-3y'+2y=1-e^{-2t}$ using Laplace transforms. Given that $y(0)=y'(0)=1$.	**3**
4C.	Draw the graph of the Periodic function $f(t)=\begin{cases} t & ;\ 0<t<\pi \\ \pi-t & ;\pi<t<2\pi \end{cases}$ and find its Laplace transform.	**3**
5A.	Obtain the region of convergence for the series $\sum\frac{x^n}{(2n-1)^2 2^n}$.	**4**
5B	Evaluate $\int_0^1\int_x^{\sqrt{2-x^2}}\frac{x}{\sqrt{x^2+y^2}}\,dy\,dx$ by changing the order of integration.	**3**
5C.	Using triple integration, find the volume of the paraboloid $x^2+y^2=4z$ cut off by the plane $z=4$.	**3**

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II SEMESTER B.TECH. END SEMESTER (MAKE-UP) EXAMINATIONS JUNE 2019

SUBJECT: ENGINEERING MATHEMATICS - II [MAT 1251]

Time : 3 hrs

Max. Marks: 50

Instructions to Candidates:

- Answer ALL the questions & missing data may be suitably assumed

1A) Expand $f(x,y) = x^2y + 3y - 2$ in powers of $(x-1)$ and $(y+2)$ up to second degree terms.

1B) Verify Cauchy Mean value theorem for the functions $f(x) = e^x$ and $g(x) = e^{-x}$ in the interval [3,5].

1C) Test the convergence of the series

$$\frac{1}{1.2.3} + \frac{3}{2.3.4} + \frac{5}{3.4.5} + \cdots$$

(4+3+3)

2A) Find the values of $'m'$ and $'n'$ such that $\lim_{x\to 0} \frac{x(1+m\cos x) - n\sin x}{x^3} = 1$.

2B) Find the maxima and minima of the function $f(x,y) = x^3 + y^3 - 3axy$ where $a \neq 0$.

2C) Find the equation of the sphere having the circle

$x^2 + y^2 + z^2 + 10y - 4z - 8 = 0, x + y + z = 3$ as a great circle.

(4+3+3)

3A) Using Laplace transforms, solve the differential equation

$y''(t) - 3y'(t) + 2y(t) = 4t + e^{3t}$, when $y(0) = 1, y'(0) = -1$.

3B) Prove that $\beta(m,n) = \frac{\Gamma m\, \Gamma n}{\Gamma(m+n)}$ for $m, n > 0$

3C) Express the function $f(t) = \begin{cases} 0, & 0 < t < 1 \\ t-1, & 1 < t < 2 \\ 1. & t > 2 \end{cases}$ in terms of unit step function and hence find $L\{f(t)\}$.

(4+3+3)

4A) Change of order of integration and hence evaluate $\int_0^a \int_{x^2/a}^{2a-x} xy\, dy\, dx$

4B) Find $L^{-1}(\log\frac{s+1}{s-1})$

4C) If $z = \sqrt{x^2+y^2}$ and $x^3 + y^3 + 3axy = 5a^2$, then find the value of $\frac{dz}{dx}$, when $x = y = a$.

(4+3+3)

5A) Evaluate $\iint (x+y)^2 dxdy$ over the region R, the parallelogram in the xy-plane with vertices $(1,0), (3,1), (2,2), (0,1)$, using the transformation $u = x + y$ and $v = x - 2y$.

5B) Find the volume of the solid bounded by the planes

$$x = 0, y = 0, x + y + z = 6 \text{ and } z = 0.$$

5C) Test the convergence of the series $\sum_{n=1}^{\infty} \frac{\sqrt{n}}{\sqrt{n^2+1}} x^n$ where $x > 0$.

(4+3+3)

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II SEMESTER B.TECH

END SEMESTER EXAMINATIONS, JUN 2019

SUBJECT: MECHANICS OF SOLIDS [CIE 1051]

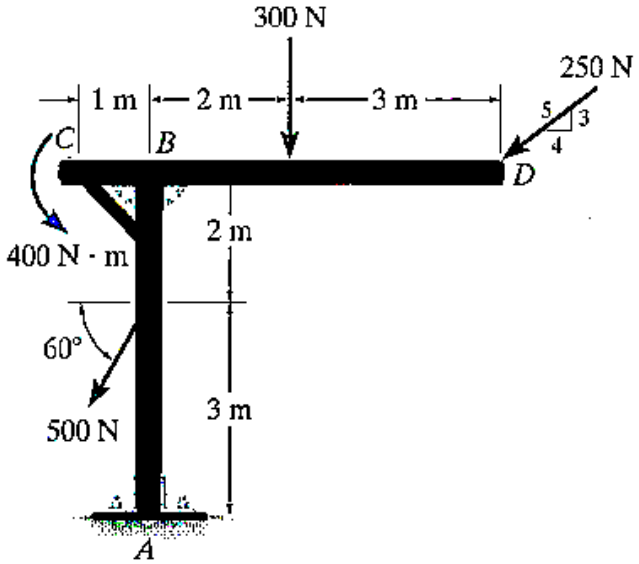
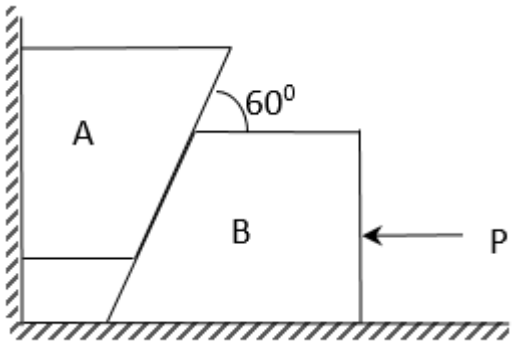
REVISED CREDIT SYSTEM

(/06/2019)

Time: 3 Hours MAX. MARKS: 50

Instructions to Candidates:

- Answer **ALL** the questions.
- Missing data may be suitably assumed.

	Questions	Marks	CO
1A.	Define couple and state any three characteristics of it.	**02**	**01**
1B.	Locate the resultant of a force system shown in the figure with respect to A. 	**04**	**01**
1C.	Block A of weight 500 N and block B of weight 1000 N are positioned as shown in the figure. Find minimum value of force P required to keep the system in equilibrium. Take coefficient of friction between floor and block as 0.25, between wall and block as 0.3 and between blocks as 0.2. 	**04**	**02**

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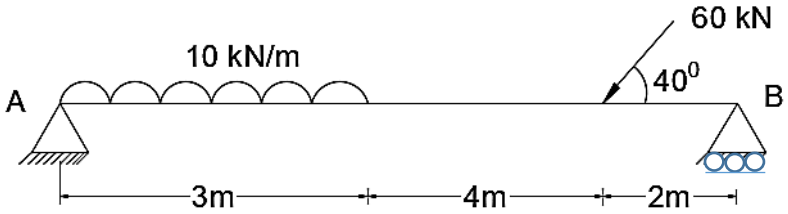
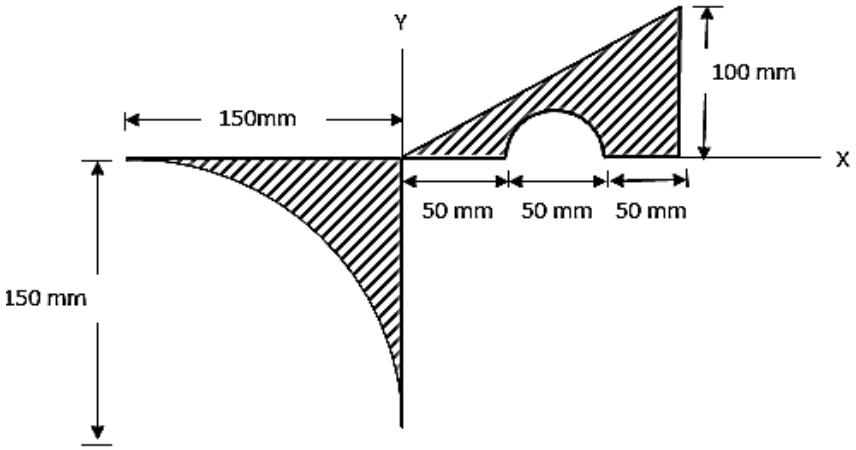
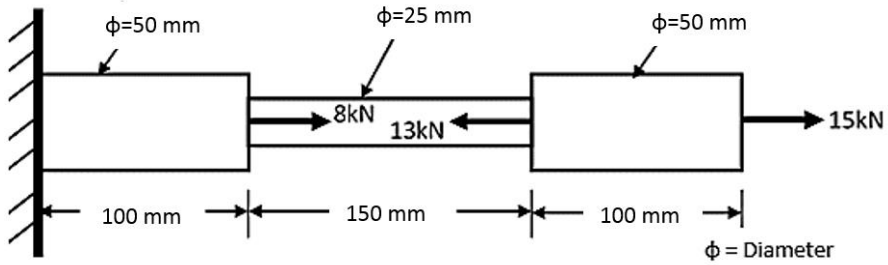
2A.	State any four laws of dry friction.	**02**	**02**
2B.	Determine the support reactions for the beam shown in the figure. 	**03**	**02**
2C.	Locate the centroid of a shaded area w.r.t. to X axis shown in the figure. 	**05**	**03**
3A.	Determine the moment of inertia for quarter circular area of radius 'R' about its base by direct integration.	**03**	**03**
3B.	A stepped rod of circular section is axially loaded at different points as shown in the figure. Calculate modulus of elasticity, if the total extension of the bar is 0.01mm. 	**04**	**04**
3C.	Draw typical stress-strain curve for ductile material subjected to tensile test and mark salient points.	**03**	**04**
4A.	A rectangular bar of cross section (100 mm × 50 mm) is 250 mm long. It is loaded with normal forces as shown in the figure. Calculate change in length, breadth, thickness and volume. Take E = 180 GPa and μ = 0.35.	**04**	**04**

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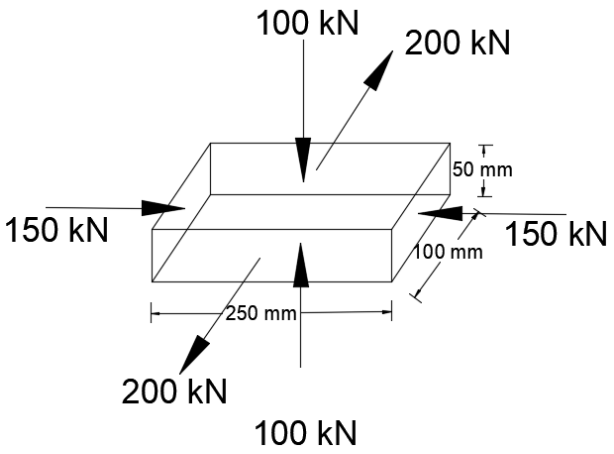
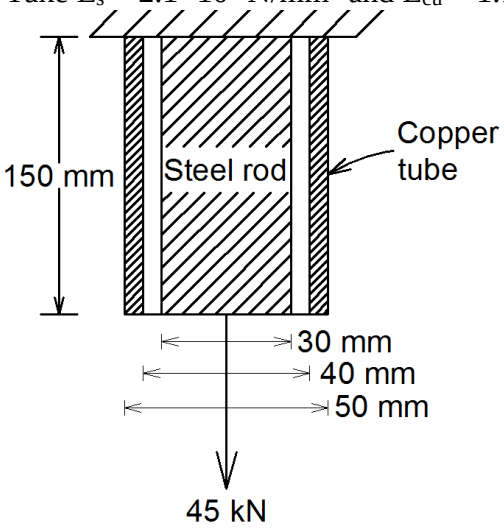
			
4B.	A thin cylinder of 1 m long has an internal diameter 230 mm and 5 mm thick wall. The change in internal volume is 12.0 x10^{-6} m^3 when filled with a liquid at pressure 'p'. If E = 200 GN/m^2 and μ= 0.25, determine the hoop and longitudinal stresses.	**03**	**04**
4C.	Show that in a state of simple shear for a square element of unit thickness, magnitude of diagonal normal stress is equal to the magnitude of applied shear stress.	**03**	**04**
5A.	A compound bar is made up of a steel rod of 30 mm diameter enclosed centrally in a hollow copper tube of external diameter 50 mm and internal diameter 40 mm as shown in the figure. The compound bar is fastened rigidly at the ends. The bar is now subjected to an axial pull of 45 kN. If the length of composite bar is 150 mm, determine: (i) The stresses developed in the rod and tube (ii) Deformation of each material Take $E_s = 2.1\times10^5$ N/mm^2 and $E_{cu} = 1.1 \times 10^5$ N/mm^2. 	**04**	**05**
5B.	A compound bar is made up of steel and aluminium and is held between two rigid supports as shown in the figure. The bars are stress free at a temperature of 42°C. What will be the stresses in two materials when the temperature increases to 66°C. Take E_{al} = 70 GPa, E_s = 200 GPa, $\alpha_{al} = 24 \times 10^{-6}$ /°C, $\alpha_s = 12 \times 10^{-6}$ /°C, A_s = 160 mm^2 and A_{al} = 240 mm^2.	**03**	**05**

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	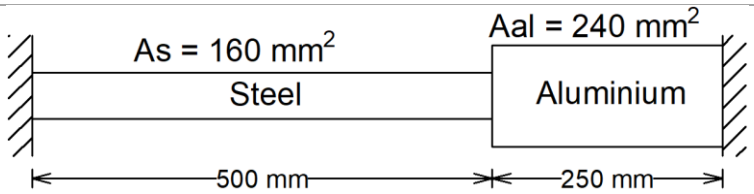		
5C.	A 1m long uniform circular bar section is rigidly fixed between two supports at its ends. If the temperature is raised by 45°C, calculate the maximum stress in the bar if one of the support yields by 0.08mm. Take E= 200 GPa, $\alpha=12\times10^{-6}$/°C.	**03**	**05**

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II SEMESTER B.TECH

END SEMESTER EXAMINATIONS, APR/MAY 2019

SUBJECT: MECHANICS OF SOLIDS [CIE 1051]

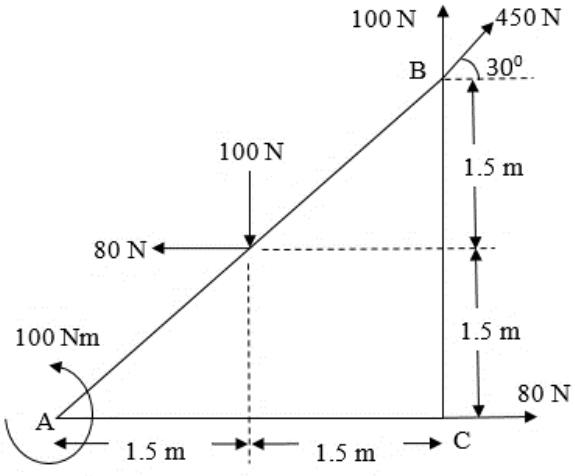
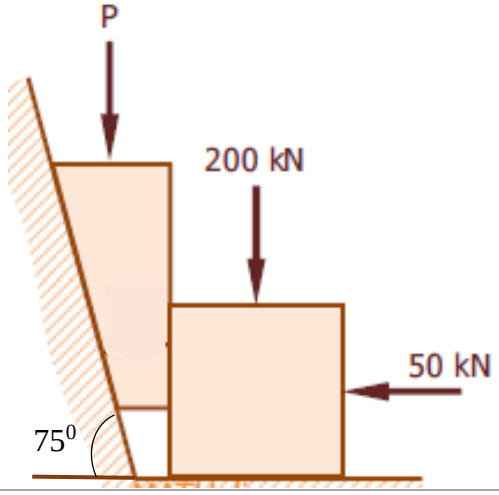
REVISED CREDIT SYSTEM

(06/04/2019)

Time: 3 Hours MAX. MARKS: 50

Instructions to Candidates:

- Answer **ALL** the questions.
- Missing data may be suitably assumed.

	Questions	Marks	CO
1A.	Explain the following and illustrate with neat sketches a) Principle of transmissibility b) Varignon's theorem	**02**	**01**
1B.	Locate the resultant of a force system shown in the figure with respect to C. 	**04**	**01**
1C.	Determine the minimum value of force P required to drive the wedge shown in the figure. The angle of friction for all surfaces in contact is 15°. 	**04**	**02**

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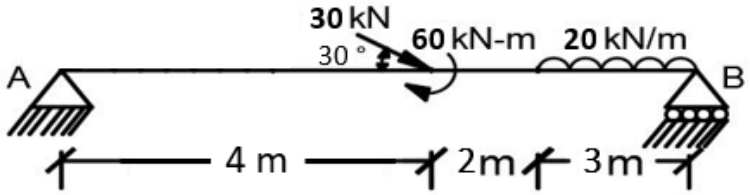
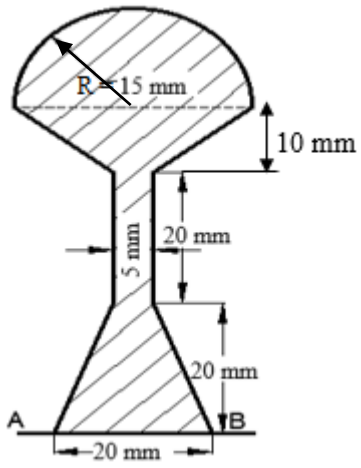
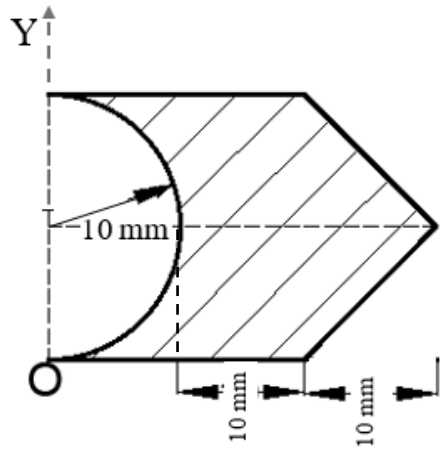
2A.	Define the following terms and illustrate with neat sketches i) Free body diagram ii) Static friction	**02**	**02**
2B.	Determine the support reactions for the beam shown in the Figure. 	**03**	**02**
2C.	Determine moment of inertia about an axis AB shown in the figure. 	**05**	**03**
3A.	Determine the centroid of a hatched area with respect to axis OY shown. 	**03**	**03**
3B.	Derive an expression for elongation of a tapered bar subjected to an axial tensile load 'P'. The flat has uniform thickness 't' and width varies uniformly from b_1 to b_2 ($b_1 < b_2$) along its length L.	**04**	**04**
3C.	The diameter of a specimen is found to reduce by 0.004 mm when subjected to a tensile force of 19 kN. The initial diameter of the specimen is 20 mm and modulus of rigidity is 40 GPa. Determine the values of E and μ.	**03**	**04**

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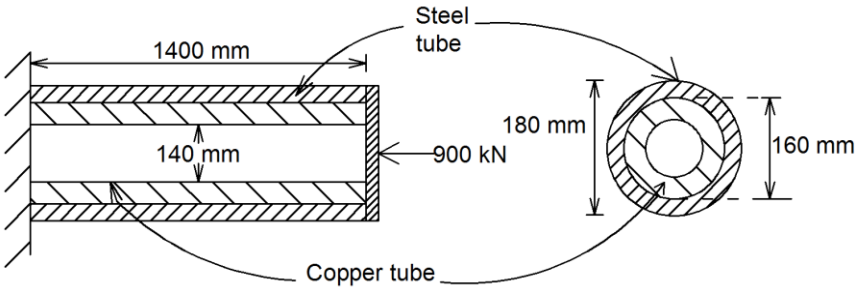
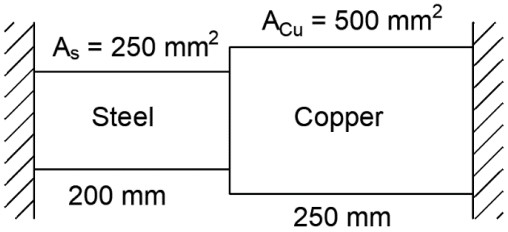
4A.	A bar of 200 mm long and 20 mm square cross section is subjected to an axial compressive load of 50 kN in longitudinal direction. The modulus of elasticity of the material is 150 GPa and Poisson's ratio is 0.30. Find the change in length, if expansions in lateral directions are prevented by the application of uniform lateral external pressure of suitable intensity.	**04**	**04**
4B.	A thin cylinder of 75 mm internal diameter, 250 mm long with walls 2.5 mm thick is subjected to an internal pressure of 7 MN/m^2. Determine the change in internal diameter, change in length, and change in volume. Take E = 200 GN/m^2, $\mu = 0.3$.	**03**	**04**
4C.	Obtain the relationship between bulk modulus (K) and modulus of elasticity (E).	**03**	**04**
5A.	A compound tube consists of a copper tube 160 mm external diameter and 140 mm internal diameter is enclosed inside a steel tube of 180 mm external diameter and 160 mm internal diameter as shown. If the compound tube carries an axial load of 900 kN, find the stresses developed and the deformation in each tube. Take $E_s = 2 \times 10^5$ N/mm^2 and $E_{cu} = 1 \times 10^5$ N/mm^2 	**04**	**05**
5B.	A bar is composed of two segments as shown in figure. Find the stress developed in each material when the temperature is raised by 60°C when the supports are perfectly rigid. Take E_s = 200 GPa, E_{Cu} = 100 GPa, $\alpha_s = 12 \times 10^{-6}$/°C, $\alpha_{cu} = 18 \times 10^{-6}$/°C. 	**04**	**05**
5C.	A rail track is to be constructed using steel rails of 20 m long. What minimum expansion gap is to be provided so that thermal stresses in rails should not exceed 70 N/mm^2 when the rails experience maximum rise in temperature of 40^0C during peak hours? Given $\alpha = 15 \times 10^{-6}$/°C and E = 210 GPa.	**02**	**05**

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SECOND SEMESTER B.TECH. DEGREE END SEMESTER EXAMINATION
APRIL/MAY 2019
SUBJECT: BASIC ELECTRONICS (ECE - 1051)

TIME: 3 HOURS **MAX. MARKS: 50**

Instructions to candidates

- Answer **ALL** questions.
- Missing data may be suitably assumed.

1A. For a fixed bias circuit Vcc =12V, R_B =240kΩ, R_C =2.2kΩ, V_{BE} = 0.7V and β = 50
   i) Draw the circuit
   ii) Determine the values of V_{CE}, I_B and I_C
   iii) Draw the DC load line and locate Q-point

1B. Draw and explain the input and output characteristics of n-p-n transistor in CB configuration indicating the different regions of operation.

1C. Reverse saturation current for a germanium diode at 27^0 C is 10μA. Calculate the current through it when the applied voltage across it is (i) 0.3V and (ii) -6V.

(4+3+3)

2A. Draw the circuit diagram of an RC coupled amplifier using n-p-n transistor. Mention the role of each component. Sketch the frequency response with and without feedback and indicate the salient features.

2B. A half wave rectifier is supplied with 120V, 50 Hz AC mains through a step down transformer with turns ratio equal to 5:1. Determine the average and RMS value of the load current for a load of 1kΩ and the PIV rating of the diode to be used for proper working. Draw the input and output waveforms.

2C. In the op-amp square wave generator, all resistors are 1kΩ and C = 0.1μF and $\pm V_{SAT}$ = ±12V. Determine the frequency of oscillation of the output signal. Also plot the voltage waveform across the capacitor and the output by marking all the timing and voltage levels.

(4+3+3)

3A. Simplify the following using K-Map and implement using only NAND gates.
F (A, B, C, D) = ∑ m (2, 3, 10, 11, 13, 15) + ∑ d (4, 7, 8, 12, 14)

3B. Realize a 3 bit asynchronous down counter using +ve edge triggered JK flip-flops. Also draw the timing diagram of each flip-flop output.

3C. Draw the logic circuit of 3 bit SISO shift register using D flip flops. Serial data 1010110010 is fed to a 3 bit SISO shift register from LSB. What will be the output of SISO operation after 7^{th} clock pulse? How many clock pulses are required to shift the MSB to the output?

(4+3+3)

4A. With a neat block diagram explain the functionalities of each block in a basic communication system.

4B. Derive the time domain expression for AM wave considering single frequency modulating wave from fundamentals and also plot the spectrum for it.

4C. A 360W carrier is simultaneously modulated by two audio waves with percentage modulation of 55 and 65 respectively. Find the modulation index, total power radiated and power in each sideband. Assume RL = 1kΩ.

(4+3+3)

5A. Explain the following pulse modulation schemes with neat waveforms.
i) PAM ii) PWM iii) PPM

5B. For the binary data 101101, Sketch ASK, FSK and PSK Signals.

5C. i) State Nyquist Sampling theorem.
ii) Consider an analog signal $3Cos(50\pi t) + 10Sin(300\pi t) - Cos(100\pi t)$. Determine the minimum sampling rate required to avoid aliasing.

(4+3+3)

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II Semester B.Tech. – END SEMESTER EXAMINATION (MAKE-UP)
SUBJECT: ENGINEERING PHYSICS

Duration: 3 hours 18-06-2019 MAXIMUM MARKS: 50

Note: Answer **ALL** the questions.
Write specific and precise answers. Missing data may suitably be assumed.
Draw neat sketches wherever necessary with axes shown properly.

1A. Using a necessary geometry and diagram, obtain an expression for the radii of bright fringes in Newton's rings. [5]

1B. A diffraction pattern is formed on a screen 120 cm away from a 0.400-mm-wide slit. Monochromatic 546.1-nm light is used. Calculate the fractional intensity I/I_{max} at a point on the screen 4.10 mm from the center of the principal maximum. [2]

1C. If the spacing between planes of atoms in a NaCl crystal is 0.281 nm, what is the predicted angle at which 0.140-nm x-rays are diffracted in a first-order maximum? Calculate the angle of incidence of the x-ray beam. [3]

2A. Apply the Schrödinger equation to a particle in a one-dimensional "box" of length L and obtain the energy values of the particle. [5]

2B. We wish to use a plate of glass (n = 1.50) in air as polarizer. Find the polarizing angle and angle of refraction. [2]

2C. Molybdenum has a work function of 4.2 eV. (a) Find the cut off wavelength and cut off frequency for the photoelectric effect. (b) What is the stopping potential if the incident light has wavelength of 180 nm? 1 eV = 1.6×10^{-19} J; Planck's constant "h"=6.63×10^{-34} Js; speed of light in vacuum "c" =3×10^{8} m/s [3]

3A. Explain three types of transitions between two energy levels, when radiation interacts with matter. [3]

3B. A quantum simple harmonic oscillator consists of an electron bound by a restoring force proportional to its position relative to a certain equilibrium point. The proportionality constant is 8.99 N/m. What is the longest wavelength of light that can excite the oscillator? [3]
Planck's constant h=6.63x10^{-34} Js; speed of light in vacuum c =3x10^{8} m/s

3C. Explain photoelectric effect. Which are the features of photoelectric effect-experiment explained by Einstein's photoelectric equation? [4]

4A. Derive an expression for density-of-states [5]

4B. For a H-atom, determine the number of allowed states corresponding to the principal quantum number n = 2, and calculate the energies of these states. [3]

4C. Most solar radiation has a wavelength of 1 μm or less. What energy gap should the material in solar cell have in order to absorb this radiation ? Is silicon (E_g= 1.14 eV) appropriate? [2]
Planck's constant "h"=6.63x10^{-34} Js; speed of light in vacuum "c" =3x10^{8} m/s

5A. With necessary diagrams, explain doping in semiconductors. [4]

5B. The frequency of photon that causes v = 0 to v = 1 transition in the CO molecule is 6.42 x 10^{13} Hz. Ignore any changes in the rotational energy. (A) Calculate the force constant k for this molecule. (B) What is the maximum classical amplitude of vibration for this molecule in the v = 0 vibrational state ? [3]
Atomic masses of C and O are 12u and 16u, respectively. 1u=1.67x10^{-27} Kg;
Planck's constant "h"=6.63x10^{-34} Js; speed of light in vacuum "c" =3x10^{8} m/s

5C. A bismuth target is struck by electrons, and x-rays are emitted. Estimate (a) the M- to L-shell transitional energy for bismuth and (b) the wavelength of the x-ray emitted when an electron falls from the M shell to the L shell. [3]
Atomic number of bismuth=83
Planck's constant "h"=6.63x10^{-34} Js; speed of light in vacuum "c" =3x10^{8} m/s

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REGISTRATION NO.									

MANIPAL INSTITUTE OF TECHNOLOGY
MANIPAL
(A constituent unit of MAHE, Manipal)

II Semester B.Tech. – END SEMESTER EXAMINATION
SUBJECT: ENGINEERING PHYSICS (PHY 1051)

Duration: 3 hours 03-05-2019 MAXIMUM MARKS: 50

Note: Answer **ALL** the questions.
Write specific and precise answers**.** Missing data may suitably be assumed.
Draw neat sketches wherever necessary with axes shown properly.

1A. Obtain an expression for intensity of light in double-slit interference. Draw a schematic plot of the intensity of light in double-slit interference against phase-difference. [5]

1B. A screen is placed 50.0 cm from a single slit, which is illuminated with light of wavelength 690 nm. If the distance between the first and third minima in the diffraction pattern is 3.00 mm, what is the width of the slit? [2]

1C. Light of wavelength 500 nm is incident normally on a diffraction grating. If the third-order maximum of the diffraction pattern is observed at 32.0°, (a) what is the number of rulings per centimeter for the grating? (b) Determine the total number of primary maxima that can be observed in this situation. [3]

2A. Using the energy and momentum conservation, derive an expression for the wavelength of the scattered photon (λ') in Compton effect experiment. [5]

2B. Un polarized light is incident upon two polarizers that have their polarization axes at an angle of 45^o. If the incident intensity is I_o, what is the final intensity? [2]

2C. An electron is confined between two impenetrable walls 0.20 nm apart. Determine its energy, momentum and de Broglie wavelength in the ground state. [3]

3A. Show that the frequency (f) and wavelength (λ) of a freely moving quantum particle with mass m are related by the expression

$$\left(\frac{f}{c}\right)^2 = \frac{1}{\lambda^2} + \frac{1}{\lambda_c^2}$$

where $\lambda_c = \frac{h}{mc}$ is the Compton wavelength of the particle. [3]

3B. The wave function for H-atom in ground state is

$$\psi_{1s}(r) = \frac{1}{\sqrt{\pi a_o^3}} e^{-\frac{r}{a_o}}$$

Obtain an expression for the radial probability density of H-atom in ground state. Sketch schematically the plot of probability density of H atom in the ground and 2s state vs. radial distance. [4]

3C. An electron has a kinetic energy of 12 eV. The electron is incident upon a rectangular barrier of height 20 eV and thickness 1 nm. By what factor would the electron's probability of tunneling through the barrier increase assuming that the electron absorbs all the energy of a photon with wavelength 546 nm? [3]
Mass of an electron = 9.1×10^{-31} Kg; Planck's constant=6.63×10^{-34} Js; 1 eV=1.6×10^{-19} J; speed of light in vacuum=3×10^8 m/s

4A. Assuming the Fermi-Dirac distribution function, obtain an expression for the density of free- electrons in a metal with Fermi energy E_F, at zero K and, hence obtain expression for Fermi energy E_F in a metal at zero K. Given: density-of-states function

$$g(E)\,dE = \frac{8\sqrt{2}\,\pi\, m^{3/2}}{h^3} E^{1/2}\,dE$$

[4]

4B. Describe the principle of a laser using necessary schematic design and energy level diagram [3]

4C. Silver is a monovalent metal. Calculate (a) Fermi energy (b) Fermi speed and (c) the de Broglie wavelength corresponding to the Fermi speed. Density of silver = 10.5×10^3 Kg/m^3 Avagadro's number = 6.023×10^{23}/ mol; Molar mass of silver is 0.107 Kg/mol ; Mass of electron = 9.1×10^{-31} Kg; Planck's constant= 6.63×10^{-34} Js; 1 eV=1.6×10^{-19} J [3]

5A. Explain briefly the BCS theory of superconductivity in metals. Why all conductors are not superconductors? [3]

5B. Obtain an expression for rotational energy of a diatomic molecule. Sketch schematically these rotational energy levels. [4]

5C. A cobalt target is bombarded with electrons, and the wavelengths of its characteristic x-ray spectrum are measured. A second, fainter characteristic spectrum is also found, due to an impurity in the target. The wavelengths of the K_α lines are 178.9 pm (cobalt) and 143.5 pm (impurity). What is the impurity ? Atomic number of Cobalt is 27. [3]
Speed of light in vacuum=3×10^8 m/s

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