



Total No. of printed pages = 8

TR/FST/AS/I/21

AGRICULTURE SCIENCE

Paper – I

Full Marks – 100

Time – Three hours

The figures in the margin indicate full marks for the questions.

Instructions :

1. Answer to Question No. 1 (i to xx) i.e., MCQ type questions under Section-A must be written in English only.

Example : The capital of India is –

- (a) Delhi (b) New Delhi
(c) Indraprastha (d) None of these

Answer : (b) New Delhi.

2. Answers to other questions except mathematical part must be written either in English or in Bengali. It must not be answered partly in English and partly in Bengali. This instruction must be followed scrupulously.
3. Candidates are required to give their answers in their own words as far as practicable.

[Turn over

SECTION - A

1. Choose the correct answer and write it down on the answer script : $1 \times 20 = 20$

(i) Which element is considered as energy currency for plant ?

- (a) N (b) P
(c) K (d) Ca

(ii) Which element is indirectly related with drought resistance in a plant ?

- (a) N (b) K
(c) P (d) Ca

(iii) The pH in soils can be raised by adding

- (a) sand (b) lime
(c) sulphur (d) nitrogen

(iv) Which of the following element is considered to be an immobile element in a plant ?

- (a) Ca (b) Mg
(c) N (d) P

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(2)

(v) CEC of which clay mineral is highest ?

- (a) Mica
(b) Vermiculite
(c) Montmorillonite
(d) Chlorite

(vi) Which one is dominant salt in alkali soil ?

- (a) CaCl_2 (b) MgSO_4
(c) NaHCO_3 (d) Na_2CO_3

(vii) The physiological disorder caused by boron deficiency in tomato is

- (a) Pulpiness
(b) Cracking
(c) Blossom end rot
(d) Silvering

(viii) Green manure plants are

- (a) Poaceae (b) Solanaceae
(c) Leguminosae (d) Compositae

(ix) A virus is made up of

- (a) Protein coat and nucleic acid
(b) Protein coat and mitochondria
(c) Nucleic acid and cell membrane
(d) Nucleic acid, cell wall and cell membrane

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(3)

[Turn over]

(x) Crop production and animal husbandry collectively called

- (a) Mixed cropping
- (b) Relay farming
- (c) Mixed farming
- (d) None of the above

(xi) Khaira disease of rice occurs due to

- (a) Deficiency of Fe
- (b) Infection fungus
- (c) Attack by mite
- (d) Deficiency of Zn

(xii) Crop rotation is defined as a

- (a) System of growing different crops on same land
- (b) System of growing different crops in succession on the same land
- (c) Method of growing different crops
- (d) System of growing the same crop on different fields

(xiii) Loss of agricultural productivity due to pests and diseases is

- (a) 30%
- (b) 5%
- (c) 1%
- (d) 10%

(xiv) A fertilizer which supplies three essential plant nutrients is

- (a) DAP
- (b) MOP
- (c) SSP
- (d) SOP

(xv) A plant breeder wants to develop a disease resistant variety. What should he do first ?

- (a) Hybridisation
- (b) Mutation
- (c) Selection
- (d) Production of crop

(xvi) Aims of plant breeding are to produce

- (a) Disease-free varieties
- (b) High-yielding varieties
- (c) Early-maturing varieties
- (d) All of the above

(xvii) The fungus biocontrol agent is

- (a) Bacillus thuringiensis
- (b) Trichoderma
- (c) Trichogramma
- (d) Helicoverpa

(xviii) The insect parasitoid is

- (a) Spider
- (b) Mexican beetle
- (c) Trichogramma spp
- (d) Damsel fly

(xix) Which one is green manure ?

- (a) Sesbania
- (b) Rice
- (c) Oat
- (d) Maize

(xx) Blind tillage refers to

- (a) Summer ploughing
- (b) Hoeing in standing crop rows
- (c) Primary tillage
- (d) Hoeing before germination.

SECTION – B

Answer any six questions :

5×6=30

- 2. Make a list of field and horticultural crops of different agro-climatic region of Tripura. 5
- 3. Explain the scope of raising various crops in Tripura. 5

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(6)

- 4. Briefly discuss the harmful effects of water-logging in crop production. Suggest some remedial measures for overcoming such water-logging. 2+3=5

- 5. Why some plants are called weeds ? Mention the reasons for popularity of chemical method of weed management in field crops among the farmers. 1+4=5

- 6. What is meant by soil moisture. Describe their different forms and their importance. 5

- 7. Write in brief the principles of crop rotation. Mention the benefits of crop rotation. 3+2=5

- 8. What are the diseases caused by plant viruses and describe their control methods. 5

- 9. Differentiate between Agro-forestry and Social forestry. Give some popular examples of Agro-forestry practiced in Tripura. 2+3=5

SECTION – C

Answer any five questions :

10×5=50

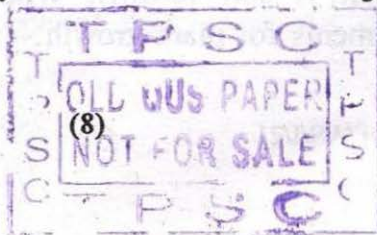
- 10. What is soil fertility. What are the essential elements for plant growth. 10

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(7)

[Turn over

11. State the various problems of soil acidity in relation to plant growth. What are the liming materials ? Suggest some suitable measures to minimize the harmful effects of salinity of soil in crop production. $3+2+5=10$
12. What is weed ? What are the injurious effects and losses caused by weeds. 10
13. Write in brief about weeds management in SRI (System of Rice Intensification). Why are high yielding varieties of rice and wheat safe to post-emergence herbicide application of 2, 4- D while dicot weeds are killed ? Suggest some important pre-emergence and post-emergence herbicides for controlling weeds in maize crop. $5+2+3=10$
14. What are the special advantages of grafting and budding as a plant propagation technique ? Describe the grafting methods for rejuvenation of old mango tree. $5+5=10$
15. Describe botanical classification of vegetables. 10
16. What are the diseases caused by plant Viruses, Bacteria and Nematodes ? Explain along with control methods. $5+5=10$



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CIVIL ENGINEERING

Paper – II

Full Marks – 100

Time – Three hours

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Instructions :

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Example : The capital of India is

- (a) Delhi (b) New Delhi
(c) Indraprastha (d) None of these

Answer : (b) New Delhi.

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SECTION - A

1. Choose the correct answer and write it on the answer script : $1 \times 20 = 20$

(i) Water absorption for first class bricks should not be more than

- (a) 12% (b) 15%
(c) 20 % (d) 25 %

(ii) Seasoning of timber is required to

- (a) soften the timber
(b) harden the timber
(c) straighten the timber
(d) remove sap from the timber

(iii) The measurement is made in square meter in case of

- (a) Cement concrete in foundation
(b) RCC structure
(c) Sand
(d) Wall painting works

(iv) While preparing a detailed estimate in construction

- (a) Dimension should be measured correct to 0.01m
(b) Area should be measured correct to 0.01 sqm
(c) Volume should be measured correct to 0.01 cum
(d) All of the above

(v) According to ISI method of measurement, the order of the sequence is

- (a) Length, breath, height
(b) Breath, length, height
(c) Height, length, breath
(d) None of the above

(vi) The soil transported by running water is called

- (a) Aeolian soil (b) Marine soil
(c) Alluvial soil (d) Lacustrine soil

(vii) Cohesionless soils are

- (a) Sands (b) Clays
(c) Silts and clay (d) None of the above

(viii) The minimum size of the grains of silts about

- (a) 0.0002 mm (b) 0.002 mm
(c) 0.02 mm (d) 0.2 mm

(ix) The ratio of the volume of voids to the total volume of soil is called

- (a) water content ratio
(b) porosity
(c) void ratio
(d) degree of saturation

(x) The specific gravity of sandy soils is

- (a) 1.2 (b) 1.8
(c) 2.2 (d) 2.6

(xi) Turbidity of raw water is a measure of

- (a) Suspended solid
(b) Acidity of water
(c) B.O.D
(d) C.O.D

(xii) Methemoglobinemia or blue baby diseases are caused due to

- (a) Chlorides (b) Nitrites
(c) Nitrates (d) Sulphides

(xiii) Los Angeles testing machine is used to conduct

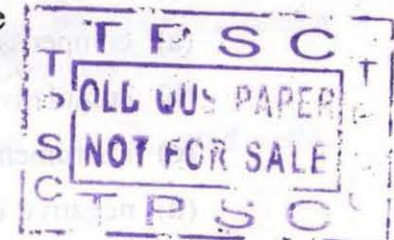
- (a) Abrasion test
(b) Impact test
(c) Attrition test
(d) Crushing strength test

(xiv) The drain which is provided parallel to roadway to intercept and divert the water from hill slope is known as

- (a) Sloping drain (b) Catch-water drain
(c) Side drain (d) Cross drain

(xv) The lowest part of the structure which transmit the load to the soil is known as

- (a) Super-structure
(b) Plinth
(c) Foundation
(d) Lintel



(xvi) The curvature of the earth is taken into consideration if the limit of survey is

- (a) 50 to 100 km²
- (b) 100 to 200 km²
- (c) 200 to 250 km²
- (d) More than 250 km²

(xvii) In order to determine the natural features such as valleys, rivers, lakes etc. the surveying preferred is

- (a) City surveying
- (b) Location surveying
- (c) Cadastral surveying
- (d) Topographical surveying

(xviii) When 1 cm on a map represents 10 m on the ground, the representative fraction of the scale is

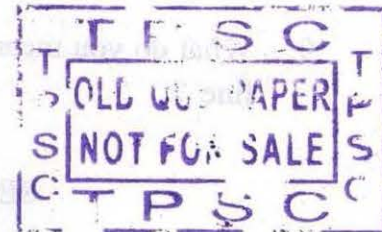
- (a) 1/10
- (b) 1/100
- (c) 1/1000
- (d) 1/10000

(xix) The error in measured length due to incorrect holding of chain is

- (a) compensating error
- (b) cumulative error
- (c) instrumental error
- (d) negative error

(xx) An open cross-staff is commonly used for setting out

- (a) short offsets
- (b) long offsets
- (c) oblique offsets
- (d) None of the above.



SECTION - B

Answer any six questions :

5×6=30

2. Draw a neat-sketch for English and Flemish bond.
3. Describe different layers of road embankment with neat sketch.
4. Define Benchmark. What are the different kinds ?
5. What is tacheometric survey ? List the methods involved ?
6. What are the differences between Prismatic Compass and Surveyors Compass ?
7. Define porosity, moisture content, void ratio, specific gravity.

8. Define Consistency index, Liquidity Index, Plasticity Index.

9. What do you mean by flow line and equipotential line ?

SECTION - C

Answer any *five* Questions : $10 \times 5 = 50$

10. Define water/cement ratio. How does it influence the strength of concrete ?

11. Describe sludge digestion process with neat sketch.

12. Give the comparison between Rise and Fall method and Line of Collimation method.

13. What are the sources of error in Theodolite work ?

14. Discuss briefly about the determination of coefficient of permeability of soil.

15. State the differences between compaction and consolidation.

16. Describe common practice of scour depth calculations for bridge pier and abutments.



Total No. of printed pages = 13

TR/FST/EE/I/21



ELECTRICAL ENGINEERING

Paper – I

Full Marks – 100

Time – Three hours

Instructions :

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Example : The capital of India is –

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Answer : (b) New Delhi.

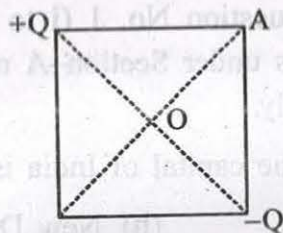
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[Turn over

SECTION - A

1. Choose the correct answer and write it on the answer script : $1 \times 20 = 20$

- (i) Two point charges $+Q$ and $-Q$ are located on two opposite corners of a square as down in Figure below. If the potential at corner 'A' is 1V, the potential at the centre 'O' of the square will be



- (a) Zero (b) $\frac{1}{\sqrt{2}}V$
(c) 1V (d) $\sqrt{2}V$

- (ii) A 1m-long conductor carries a current of 50A at right angles to a magnetic field of 100×10^{-3} . The force on the conductor is

- (a) 5000 N (b) 500 N
(c) 50 N (d) 5 N

- (iii) Each branch of a star connected load has a resistance of 10Ω . The resistance of each branch of an equivalent delta connection will be

- (a) 30Ω (b) 100Ω
(c) 3.33Ω (d) None of the above

- (iv) When maximum power transfer takes place, the efficiency of power transfer of the circuit is -

- (a) 100% (b) 75%
(c) 50% (d) 25%

- (v) Two coils of in differential connection have self inductance of 2mH and 4mH and a mutual inductance of 0.15mH. The equivalent inductance of the combination is

- (a) 5.7mH (b) 5.85mH
(c) 6.15mH (d) 6.3mH

- (vi) A pure inductance and a capacitance have reactances of 100Ω each and are connected in parallel across an a.c. supply of 220V. What is the current drawn from the supply ?

- (a) 4.4A (b) 1.1A
(c) 0A (d) None of the above

(vii) Which of the following statements are true with regard to resistance ?

- (a) Resistance is directly proportional to the length of the wire
- (b) Resistance is directly proportional to the area of cross section of the wire
- (c) Resistance is inversely proportional to the length of the wire
- (d) Resistance is inversely proportional to the resistivity of the wire

(viii) An AC circuit has a resistance of R ohm, an inductance of L henry, and a capacitance of C farad connected in series. The power factor of the circuit will be unity when

- (a) $X_L < X_C$
- (b) $X_L = X_C$
- (c) $X_L > X_C$
- (d) $R = \tan^{-1} \frac{X_L}{X_C}$

(ix) The current $i(t)$, through a 10Ω resistor in series with an inductor is given by $i(t) = 3 + 4 \sin(100t + 45^\circ) + 5 \sin(300t + 60^\circ)$ A. The r.m.s. value of the current and the power dissipated in the circuit are

- (a) $\sqrt{41}$ A, 410W respectively
- (b) $\sqrt{35}$ A, 350W respectively
- (c) 5A, 350W respectively
- (d) 11A, 1210W respectively

(x) A delta connected balanced load having three equal resistances of 83Ω (each) is connected across a 3ph, 415V, 50Hz supply. How much is the line current ?

- (a) 0A
- (b) 5A
- (c) $8.66A$
- (d) 10A

(xi) The average value of the half-wave rectified sine wave of amplitude A_m is

- (a) $\frac{A_m}{\pi}$
- (b) $\frac{A_m}{\sqrt{2}}$
- (c) $\frac{A_m}{2}$
- (d) $\frac{2A_m}{\pi}$

(xii) Which of the following method can be employed to use a voltmeter as an ammeter ?

- (a) a low resistance across the terminals of the voltmeter
- (b) a low resistance in series with the voltmeter
- (c) a high resistance across the terminals of the voltmeter
- (d) a high resistance in series with the voltmeter

(xiii) In a megger the most widely used voltage source is

- (a) normal domestic supply
- (b) a Ni-Cd battery
- (c) a lead-acid battery
- (d) hand-driven generator

(xiv) Which of the following is an advantage of using distributed winding in a three-phase alternator ?

- (a) the generated e.m.f approximates more closely to sine wave
- (b) efficient utilization of the stator periphery
- (c) generation of high voltages
- (d) All of the above.

(xv) An electromechanical energy conversion device has cylindrical stator but salient pole rotor. If δ is the angle between the stator field and rotor field, then average torque developed is proportional to (A and B are constants).

- (a) $A \sin \delta$
- (b) $A \sin 2\delta$
- (c) $A \sin \delta + B \sin 2\delta$
- (d) δ

(xvi) In a transformer, the tapings are provided on

- (a) h. v. side at one end of the winding
- (b) h. v. side at the middle
- (c) l. v. side at one end of the winding
- (d) l. v. side at the middle.

(xvii) At 50 Hz operation, a single phase transformer has hysteresis loss of 200 W and eddy current loss of 100 W. Its core loss at 60 Hz operation will be

- (a) 432 W
- (b) 408 W
- (c) 384 W
- (d) 360 W

(xviii) A 220V D.C machine has an armature resistance of 1Ω . If the full load current is 20A, the difference in the induced voltages when the machine is running as a motor and as a generator is

- (a) 40 V
- (b) 20 V
- (c) zero
- (d) 50 V

(xix) If the field of a D.C shunt motor gets open while the motor is running, then the

- (a) speed of motor will be reduced
- (b) motor will attain dangerously high speed
- (c) armature current will drop
- (d) None of these

(xx) The Laplace transform of a unit-ramp function starting at $t = a$ is

- (a) $\frac{1}{(s+a)^2}$
- (b) $\frac{e^{-as}}{(s+a)^2}$
- (c) $\frac{e^{-as}}{s^2}$
- (d) $\frac{a}{s^2}$

SECTION - B

Answer any six questions :

5×6=30

2. Two charges of opposite sign and magnitude 10^{-9} coulomb each are located 6 metres apart
- (i) Calculate the resulting electric potential at a point which is midway between the two charges and 4 metres from the line joining the charges.

(ii) What is the potential at the point if both the charges are positive ? 3+2=5

3. A combination of resistance R and inductance L is connected across 240V, 50Hz, 1 ph power supply. Power dissipated in the circuit is 300 W and the voltage across R is 100 V. Calculate the capacitance of the capacitor C which needs to be connected in series with R and L in order to improve the power factor to unity. 5

4. Three resistances $R_{ab}(=5\Omega)$, $R_{bc}(=15\Omega)$ and $R_{ca}(=30\Omega)$ are connected in delta. Calculate the equivalent star resistances R_{an} , R_{bn} and R_{cn} where n is the common neutral point in star configuration. 5

5. (i) Explain why the e.m.f generated in the armature of a D.C motor is called 'back e.m.f' ? 3

(ii) Four terminals of a D.C shunt machine are available, but these are unmarked. How would you identify the field and armature terminals ? 2

6. Magnetic axes of three coils a , b , c are displaced by 120° . If these coils are excited by three phase balanced currents $I_m \cos \omega t$, $I_m \cos (\omega t - 120^\circ)$ and $I_m \cos (\omega t + 120^\circ)$ respectively, what sort of

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SECTION – B

Answer any six questions : 5×6=30

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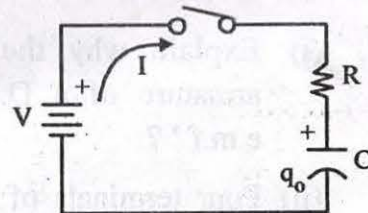
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magnetic field will be produced by (a) each individual coils and (b) the combined effect of current flow through 3 coils. (c) Find the magnitude of resultant m.m.f wave. $1+1+3=5$

7. Draw the exact equivalent circuit of a transformer and explain the various parameters involved in it. 5

8. Explain how deflecting torque, controlling torque and damping torque are produced in a permanent magnet moving coil ammeter. What would happen if the damping torque is absent? $4+1=5$

9. The series RC circuit of the adjoining Figure has an initial charge q_0 on the capacitor with the polarity shown in the diagram. When the



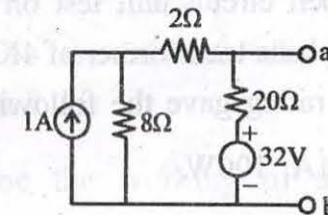
switch is closed the constant voltage source V is applied to the circuit. Write down the differential equation solving which it is possible to know the variation of current i w.r.t. time and solve it using Laplace Transform method. $1+4=5$

SECTION - C

Answer any five questions :

$10 \times 5 = 50$

10. (i) State and explain Thevenin's theorem. 4
(ii) Find the Thevenin equivalent of the circuit shown in the adjoining Figure. 6



11. The power input to a 2200V, 50Hz, 3 phase motor, running on full load is measured by two wattmeters, which indicate 500 kW and 200 kW. Calculate (a) the total power (b) the power factor and (c) the line current. $2+4+4=10$

12. (a) Define and explain (i) magnetic field strength (ii) magnetomotive force. $2+2$

- (b) State and explain Ampere's circuital law. 2

- (c) An iron ring 25 cm in diameter and 10 cm^2 cross section is wound with 250 turns of wire. For a flux density of 1 wb/m^2 and a permeability of 800 find the exciting current. 4

13. (a) What are the functions of the following components of an oil filled transformer. 2+2

(i) Conservator

(ii) Breather.

(b) The open circuit unit test on L.V side of a single phase transformer of 4KVA, 200/400V, 50 Hz rating gave the following result :

200V, 1A, 100W.

Determine the conductance and susceptance of the shunt element of the transformer equivalent circuit. 6

14. (a) In connection with rotating electrical machine explain the following terms : 6

(i) Pole pitch

(ii) Full-pitch coil

(iii) Short pitch coil.

(b) Why are some parts of electrical machines laminated ? 2

(c) Distinguish between electromagnetic torque and reluctance torque. 2

15. (a) Describe, with relevant diagrams, the different methods of excitation of D.C machines. 3

(b) What is meant by armature reaction ? 2

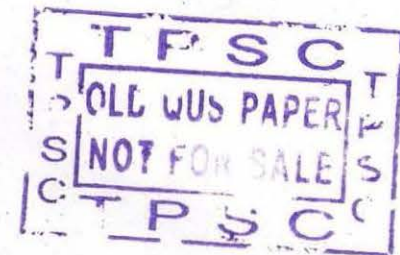
(c) Show that the effect of armature m.m.f on the main field is entirely cross magnetizing. 2

(d) What are the adverse effects of armature reaction ? 3

16. (a) Describe the working of a moving coil permanent magnet instrument. 6

(b) Explain how the range of an ammeter can be extended. 2

(c) Explain the term ammeter sensitivity. 2



Total No. of printed pages = 12

TR/FST/ME/I/21

MECHANICAL ENGINEERING

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Full marks – 100

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[Turn over

SECTION - A

(Answer all questions)

1. Choose the correct answer and write it on the answer script : $1 \times 20 = 20$

(i) Within elastic limit in a loaded material, stress is

- (a) inversely proportional to strain
- (b) directly proportional to strain
- (c) equal to strain
- (d) None of the above

(ii) When two mutually perpendicular principal stresses are unequal but alike, the maximum shear stress is represented by

- (a) the diameter of the Mohr's circle
- (b) half ($1/2$) the diameter of the Mohr's circle
- (c) one-third ($1/3$ rd) the diameter of the Mohr's circle
- (d) one-fourth ($1/4$ th) the diameter of the Mohr's circle.

(iii) A tensile force P is acting on a body of length L and area of cross-section A . The change in length would be

- (a) P/LAE
- (b) PE/AL
- (c) PL/AE
- (d) AL/PE

(iv) A long helical spring having a spring stiffness of 12 kN/m and number of turns 20 , breaking into two parts with number of turns 10 each in both parts. If the two parts are connected in series, then the stiffness of the resultant spring will be

- (a) 6 kN/m
- (b) 12 kN/m
- (c) 24 kN/m
- (d) 30 kN/m

(v) The point of zero bending moment, where the continuous curve of bending moment changes, sign is called

- (a) the point of contraflexure
- (b) the point of inflexion
- (c) the point of virtual hinge
- (d) All of the above



(vi) The maximum deflection of a fixed beam of length l carrying a central point load W is

- (a) $Wl^3/48EI$ (b) $Wl^3/96EI$
(c) $Wl^3/192EI$ (d) $Wl^3/384EI$

E = modulus of elasticity; I = moment of inertia

(vii) The differential mechanism of an automobile is having

- (a) one degree of freedom
(b) two degree of freedom
(c) three degree of freedom
(d) zero degree of freedom

(viii) A cantilever beam carries a load ' W ' uniformly over entire length. If the same load is applied at the free end of the same cantilever, then the ratio of maximum deflection in the first case to that in the second case will be

- (a) $3/8$ (b) $8/3$
(c) $5/8$ (d) $8/5$

(ix) If T_1 and T_2 are the tensions on the tight side and slack side of a belt and θ is the angle of contact, then the ratio of tension is given by

- (a) $T_1/T_2 = \mu\theta$ (b) $T_1/T_2 = e^{\mu\theta}$
(c) $T_1/T_2 = e^{1/\mu\theta}$ (d) $T_1/T_2 = \mu e^{\theta}$

(x) When maximum horse power is transmitted, the effective tension in the tight side of the belt is equal to

- (a) twice the centrifugal tension
(b) three times the centrifugal tension
(c) half of the centrifugal tension
(d) one-third of the centrifugal tension

(xi) Auto fretting is the method of

- (a) joining thick cylinders
(b) calculating stresses in thick cylinders
(c) pre-stressing thick cylinders
(d) increasing the life of thick cylinders

(xii) The relationship between constants E, G and k is given by

(a) $E = \frac{G+3k}{9kG}$

(b) $\frac{3G+k}{9kG}$

(c) $\frac{9kG}{G+3k}$

(d) $\frac{9kG}{3k+G}$

(xiii) The Beaufort scale is used to describe what ?

(a) weather severity

(b) rainfall

(c) wind direction

(d) wind speed strength

(xiv) The process which improves the machinability of steels, but lowers the hardness and tensile strength is

(a) normalising

(b) full annealing

(c) process annealing (d) spheroidising

(xv) In order to avoid tearing of the plate at an edge, the distance from the centre line of the rivet of diameter to the nearest edge of the plate should be equal to

(a) d

(b) 1.5d

(c) 2.0d

(d) 2.5d

(xvi) Low helix angle drills are preferred for drilling holes in

(a) plastics

(b) copper

(c) cast steel

(d) carbon steel

(xvii) If the rotating mass of a rim type flywheel is distributed on another rim type whose mean radius is half the mean radius of the former, then energy stored in the later at the same speed will be

(a) four times of the first one

(b) same as the first one

(c) one-fourth of the first one

(d) one and half times of the first one

(xviii) The relationship between tool life T and cutting speed V is $VT^n = \text{Constant}$. In this relation the value of n depends upon

- (a) work material
- (b) tool material
- (c) working condition
- (d) type of chip produced

(xix) The lead angle of a worm is 22.5° . Its helix angle will be

- (a) 22.5°
- (b) 45°
- (c) 67.5°
- (d) 90°

(xx) The permissible stress in a fillet weld is 100 N/mm^2 . The fillet weld has equal leg lengths of 15 mm each. The allowable shear load on weldment per cm length of the weld is

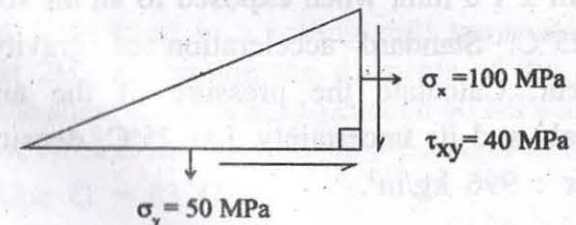
- (a) 10.6 kN
- (b) 15.0 N
- (c) 22.5 kN
- (d) 7.5 kN

SECTION - B

Answer any six questions :

$5 \times 6 = 30$

2. What is meant by machining? What are the conditions for machining principle?
3. Draw a shear force and bending moment diagrams for a cantilever of length L carrying a point load W at the free end.
4. A cantilever of length 3 m is carrying a point load of 25 kN at the free end. If the moment of inertia of the beam is 10^8 mm^4 and value of $E = 2.1 \times 10^5 \text{ N/mm}^2$, find the deflection at the free end.
5. Derive an expression for the velocity ratio of a belt drive considering thickness of the belt.
6. State the fundamental laws of gearing. State when the meshing surfaces can be called conjugate.
7. The state of stress in a point of material is shown in figure below. Determine the direction and magnitude of the principal stresses.



8. Design a triple riveted longitudinal double strap butt joint with unequal strap for a boiler. The inside diameter of the longest course of the drum is 1.3 metre. The joint is to be designed for steam pressure of 2.4 N/mm^2 . The working stress to be used are $\sigma_t = 77 \text{ N/mm}^2$, $\sigma_s = 62 \text{ N/mm}^2$, $\sigma_c = 120 \text{ N/mm}^2$. Assume the efficiency of the joint is 81%.
9. What are the various characteristics of a grinding wheel?

SECTION - C

Answer any five questions :

$10 \times 5 = 50$

10. A U-tube manometer employs a special oil having a specific gravity of 0.82 for the manometer fluid. One side of the manometer is open to local atmospheric pressure of 74.422 cm Hg and the difference in column heights is measured as $20 \text{ cm} \pm 1.0 \text{ mm}$, when exposed to an air source at 25°C . Standard acceleration of gravity is present. Calculate the pressure of the air in Pascals and its uncertainty. [At 25°C , density of water : 996 kg/m^3].

11. A horizontal overhanging beam of length 6m, carrying uniformly distributed load of 2 kN/m over the entire length and a point load of 2 kN acts at the right extreme end. Two reactive forces are applied at 2m from right extreme end and at left extreme end. Draw shear force and bending moment diagram.

12. Explain the difference between orthogonal and oblique cutting. In an orthogonal cutting process, the following observations were made :

Depth of cut = 0.25 mm

Chip thickness ratio = 0.45

Width of cut = 4 mm

Cutting velocity = 40 m/min

Cutting force component parallel to cutting velocity vector = 1150 N

Cutting force component normal to cutting velocity vector = 140 N

Rake angle of tool = 18°

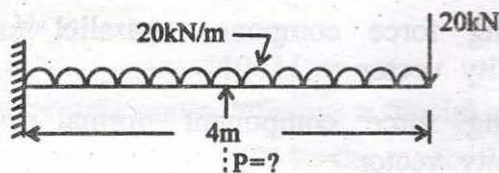
Determine resultant cutting force, power of cutting, shear plane angle, friction angle.

13. A solid shaft in a rolling mill transmits 20 kW at 2 Hz , determine the diameter of the shaft, if the shear stress is not to exceed 40 MPa and angle of twist is limited to 6° in 3 m length of the shaft. Use $G = 83 \text{ GPa}$.

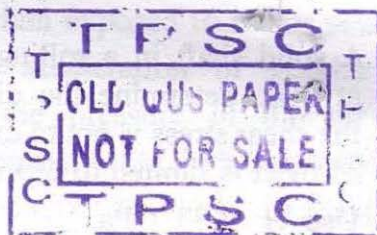
14. A rope drive transmits 800 h.p from a pulley of effective diameter 4m, which runs at a speed of 90 rpm. The angle of lap is 160° , the angle of groove is 45° , the coefficient of friction is 0.28, the weight of the rope is 1.5 kgf/m and the allowable tension in each rope 240 kgf. Find the number of ropes required.

15. (i) Find the slope and deflection at the tip of the cantilever shown below :

- (ii) What load 'P' must be applied upwards at mid span to reduce the deflection by half? [$EI = 20 \text{ MNm}^2$].



16. Explain the terms roughness, waviness and lay. How the surface roughness is generally measured?



Total No. of printed pages = 12

TR/FST/EE/II/21

ELECTRICAL ENGINEERING

Paper – II

Full Marks – 100

Time – Three hours

The figures in the margin indicate full marks for the questions.

Instructions :

1. Answer to Question No. 1 (i to xx) i.e., MCQ type questions under Section-A must be written in English only.

Example : The capital of India is –

- (a) Delhi (b) New Delhi
(c) Indraprastha (d) None of these

Answer : (b) New Delhi.

2. Answers to other questions except mathematical part must be written either in English or in Bengali. It must not be answered partly in English and partly in Bengali. This instruction must be followed scrupulously.
3. Candidates are required to give their answers in their own words as far as practicable.

[Turn over

SECTION – A

1. Choose the correct answer and write it on answer script :

(i) Aluminium is now most commonly employed conductor material in transmission lines than copper because –

- (a) it is more conductive
- (b) its tensile strength is more
- (c) it is costlier
- (d) it is cheaper and lighter

(ii) The “skin effect” shows that –

- (a) the distribution of the AC current is uniform through the cross section of the conductor
- (b) current density for AC is more at the centre of the conductor
- (c) current density for AC is highest at the surface of the conductor.
- (d) None of the above

(iii) The receiving-end voltage for a long line under no load condition is

- (a) less than the sending-end voltage
- (b) more than the sending-end voltage
- (c) equal to the sending-end voltage
- (d) Any one of the above

(iv) If V_s and V_r denote sending-end and receiving-end voltage respectively and δ denotes power angle, the transfer of reactive power mainly depends on

- (a) V_r (b) V_s
- (c) $|V_s| - |V_r|$ (d) $|V_s| - |V_r|\sqrt{\cos\delta}$

(v) The insulation resistance of a single core cable is $160 \text{ M}\Omega/\text{km}$. The insulation resistance for 4 km length is

- (a) $40 \text{ M}\Omega$ (b) $80 \text{ M}\Omega$
- (c) $120 \text{ M}\Omega$ (d) $320 \text{ M}\Omega$

(vi) EHV cables are filled with thin oil under pressure

- (a) to prevent entry of air and moisture
- (b) to strengthen the cable conductor
- (c) to provide extra insulation
- (d) to avoid formation of voids

(vii) A Buchholz relay is used to protect

- (a) a transformer
- (b) an alternator
- (c) an induction motor
- (d) HVDC line

(viii) Corona loss is less when the shape of the conductor is

- (a) flat (b) circular
(c) oval (d) independent of shape

(ix) A synchronous generator is feeding power to an infinite bus at unity power factor. Its excitation is now increased. It will feed

- (a) the same active power but at a lagging power factor
(b) the same active power but at a leading power factor
(c) more active power at unity power factor
(d) less active power at unity power factor

(x) By adding resistance in the rotor circuit of a slip ring induction motor the starting current

- (a) and torque both reduce
(b) and torque both increase
(c) reduces but starting torque increases
(d) increases but starting torque decreases

(xi) A single phase induction motor

- (a) can not produce starting torque but can produce running torque
(b) can produce only starting torque but not any running torque
(c) can produce both starting and running torque
(d) can produce neither starting torque nor running torque.

(xii) The work done by the force $F = 4a_x - 3a_y + 2a_z$ N in giving a 1 nC charge a displacement of $10a_x + 2a_y - 7a_z$ m is

- (a) 103 nJ (b) 60 nJ
(c) 64 nJ (d) 20 nJ

(xiii) What happens when a steady potential difference is applied across the ends of a conducting wire ?

- (a) All electrons move with a constant velocity.
(b) All electrons move with a constant acceleration.

(c) The random electronic motion will, on the average, be equivalent to a constant velocity of each electron.

(d) The random electronic motion will, on the average, be equivalent to a non-zero constant acceleration of each electron.

(xiv) When a transistor is operating in active region

(a) collector junction is forward biased

(b) collector junction is reverse biased

(c) both collector and emitter junctions are reverse biased

(d) both collector and emitter junctions are forward biased

(xv) An ideal voltage amplifier will have

(a) zero output resistance and infinite input resistance

(b) zero input resistance and infinite output resistance

(c) both input and output resistances are zero

(d) both input and output resistances are infinite

(xvi) In exclusive Or gate, when output is zero the inputs are

(a) 0, 1 (b) 1, 0

(c) 1, 1 (d) Any one of the above

(xvii) In a microprocessor, the address of the next instruction to be executed, is stored in

(a) stack pointer

(b) address latch

(c) program counter

(d) general purpose register

(xviii) The resolution of a D/A converter is approximately 0.4% of its full scale range. It is

(a) an 8-bit converter

(b) a 16-bit converter

(c) a 32-bit converter

(d) None of the above

(xix) For the characteristic equation $s^2 + 4.8s + 72 = 0$, the damping ratio and natural frequency are respectively

(a) 0.212, 8.1 rad/s

(b) 0.283, 8.48 rad/s

(c) 0.299, 8.66 rad/s

(d) None of the above



(xx) The number of roots of $s^3 + 5s^2 + 7s + 3 = 0$ in the right half of the S-plane is

- (a) zero (b) one
(c) two (d) three.

SECTION - B

Answer any six questions :

5×6=30

2. Draw the nominal- π equivalent circuit of a medium line with a per phase series impedance of Z and phase to neutral shunt admittance of Y . Find the A,B,C,D parameters of this line in terms of Y and Z .
3. Explain what is meant by 'corona' in a high voltage transmission line. What are the advantages and disadvantages of corona ? What are the commonly used methods of reducing corona loss ?
4. A single line to ground fault has occurred at the terminals of a 3-ph synchronous generator with a voltage rating V . The alternator neutral is grounded through an impedance of Z_n and its +ve, -ve and zero sequence reactances are X_1 , X_2 and X_0 respectively. How will you calculate the fault current ?

1+2+2=5

5

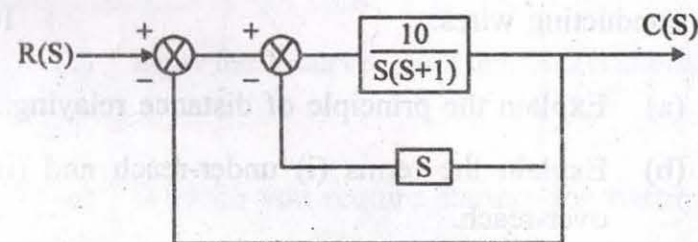
5. (a) Sketch the typical torque speed characteristics of an induction motor.
(b) How is this characteristics modified
(i) if its rotor circuit resistance is increased
(ii) if its rotor circuit reactance is increased ?

2+3=5

6. A 3 phase alternator is to be connected to grid after synchronization. What conditions need to be fulfilled for successful synchronization ?
7. For the system shown below determine the transfer function $C(S)/R(S)$:

5

5



8. A charged particle of mass 2kg and charge 3C starts at point (1, -2, 0) with velocity $4a_x + 3a_z$ m/s in an electric field $12a_x + 10a_y$ v/m. At time $t = 1s$, determine
(a) the acceleration of the particle.
(b) its velocity.

2+3=5

9. (a) Draw a full adder circuit using suitable gates. 2

(b) Write the logical equations for SUM and CARRY for full-adder. 3

SECTION – C

Answer any *five* questions : 10×5=50

10. Derive a mathematical expression for the inductance L of a single phase two wire line in terms of r and D where r is the radius of the conducting wire and D is the distance between the two conducting wires. 10

11. (a) Explain the principle of distance relaying. 2

(b) Explain the terms (i) under-reach and (ii) over-reach. 4

(c) Draw the characteristics of a (i) mho relay and (ii) reactance relay on a R - X plane clearly indicating the operating zone and blocking zone. 4

12. (a) Explain how arc is produced and it is quenched in a vacuum circuit breaker when it trips after a fault. 4

(b) Explain the following terms (i) Breaking current (ii) Making current and (iii) Short time rating of a circuit breaker. 6

13. (a) What type of alternators will be used

(i) for hydraulic turbine and

(ii) for steam turbine as prime movers.
Justify your answer. 4

(b) Why are X_d and X_g value different for salient pole alternator whereas they are same for cylindrical rotor machine ? 3

(c) Draw the V-curve of a synchronous alternator. 3

14. (a) Why do you require starters for starting of 3-phase induction motors ? 2

(b) Draw a neat diagram for a star-delta starter, describe its principle of operation and state its advantages over direct on line starting. 6

(c) How can you run an induction machine as an induction generator. 2

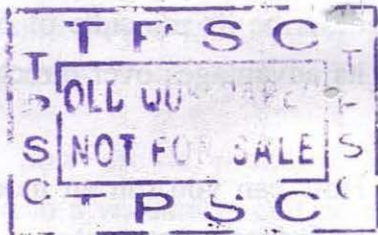
15. The closed loop transfer function for a standard second order system takes the form

$$\frac{C(s)}{R(s)} = \frac{w_n^2}{s^2 + 2\zeta w_n s + w_n^2}$$

Draw a sketch for the response $c(t)$ when a unit step input signal is applied and explain the following terms (i) Delay time T_d (ii) Rise time T_r (iii) Peak overshoot M_p and (iv) Setting Time T_s .

$$2+2+2+2+2=10$$

16. (a) Express the principle of feedback in amplifiers and derive an expression for the closed-loop gain of the amplifier in terms of open-loop gain A . 3
- (b) What are the advantages of negative feedback in amplifiers? 4
- (c) Explain Barkhausen criteria. 3



Total No. of printed pages = 12

TR/FST/ME/II/21

MECHANICAL ENGINEERING

Paper : II

Full marks – 100

Time – Three hours

The figures in the margin indicate full marks for the questions.

Instructions :

1. Answer to Question No. 1 (i to xx) i.e., MCQ type questions under Section – A must be written in English only.

Example : The capital of India is

- (a) Delhi (b) New Delhi
(c) Indraprastha (d) None of these

Answer : (b) New Delhi.

2. Answers to other questions except mathematical part must be written either in English or in Bengali. It must not be answered partly in English and partly in Bengali. This instruction should be followed scrupulously.
3. Candidates are required to give their answers in their own words as far as practicable.

[Turn over

SECTION - A

(Answer *all* questions)

1. Choose the correct answer and write it on the answer script : $1 \times 20 = 20$

(i) Kelvin-Planck's law deals with

- (a) Conservation of work
- (b) Conservation of heat
- (c) Conversion of heat into work
- (d) Conversion of work into heat

(ii) The efficiency of Carnot cycle depends upon

- (a) temperature limits
- (b) pressure ratio
- (c) volume compression ratio
- (d) cut off ratio and compression ratio

(iii) The efficiency of diesel cycle approaches to Otto cycle efficiency when

- (a) Cut off is increased
- (b) Cut off is decreased
- (c) Cut off is zero
- (d) Cut off is constant

24/TR/FST/ME/II/21 (2)

(iv) A spherical black body with a radius of 12 cm radiates 450w power at 500k. If the radius was halved and the temperature is doubled, the power radiated in watts would be

- (a) 225
- (b) 450
- (c) 900
- (d) 1800

(v) A cylinder of radius 'R' is surrounded by a cylindrical shell of inner radius 'R' and outer radius '2R'. The thermal conductivities of inner and outer cylinder are ' k_1 ' and ' k_2 ' respectively. Assuming no heat loss, the effective thermal conductivity of the system for heat flowing along the length of the cylinder is

- (a) $\frac{k_1 + 3k_2}{4}$
- (b) $\frac{k + k_2}{2}$
- (c) $\frac{k_1 + 4k_2}{3}$
- (d) $\frac{2k_1 + 3k_2}{5}$

24/TR/FST/ME/II/21 (3)

[Turn over

(vi) A valve installed between the boiler and feed pump is

- (a) blow off cock (b) feed check valve
- (c) steam stop valve (d) None of these

(vii) In Orsat apparatus

- (a) CO_2 is absorbed in cuprous chloride
- (b) CO is absorbed in caustic potash solution
- (c) O_2 is absorbed in pyrogalllic acid
- (d) N_2 is absorbed in hot nickel chroma compound

(viii) Specific speed of a pump is given as (symbols have the usual meanings)

- (a) $\frac{N\sqrt{Q}}{H^{3/4}}$
- (b) $\frac{N\sqrt{Q}}{H^{5/4}}$
- (c) $\frac{Q\sqrt{N}}{H^{3/2}}$
- (d) $\frac{Q\sqrt{N}}{H^{5/2}}$

(ix) The Euler's equation for the motion of liquid is based on the assumptions that

- (a) the fluid is non-viscous, homogeneous and incompressible
- (b) the velocity of flow is uniform over the section
- (c) the flow is continuous, steady and along the streamline
- (d) All of the above

(x) The hydraulic mean depth or the hydraulic radius is the ratio of

- (a) area of flow and wetted perimeter
- (b) wetted perimeter and diameter of pipe
- (c) velocity of flow and area of flow
- (d) None of these

(xi) The purpose of surge tank is

- (a) to control the pressure variations due to rapid changes in the pipe line flow
- (b) to eliminate water hammer possibilities

(c) to regulate flow of water to turbines by providing necessary retarding head of water

(d) All of these

(xii) The Magnus effect is defined as

(a) the generation of lift per unit drag force.

(b) the circulation induced in an aircraft wing.

(c) the separation of boundary layer near the trailing edge of a slender body.

(d) the generation of lift on a rotating cylinder in a uniform flow.

(xiii) Compression ratio for diesel engines is

(a) 6 to 10

(b) 10 to 15

(c) 15 to 25

(d) 25 to 40

(xiv) A beaker contains 200g of water. The heat capacity of the beaker is equal to that of 20g of water. The initial temperature of water in the beaker is 20°C . If 440g of hot water at 92°C is poured in it, the final temperature will be nearest to

(a) 58°C

(b) 68°C

(c) 73°C

(d) 78°C

(xv) Slip of a reciprocating pump is negative, when

(a) suction pipe is short and pump is running at low speeds

(b) delivery pipe is long and pump is running at high speeds

(c) suction pipe is short and delivery pipe is long and the pump is running at low speeds

(d) suction pipe is long, delivery pipe is short and the pump is running at high speeds

(xvi) A Carnot engine takes 3×10^6 cal of heat from a reservoir at 627°C and gives it to sink at 27°C . The work done by the engine is

- (a) 4.2×10^6 J (b) 8.4×10^6 J
(c) 16.8×10^6 J (d) Zero J

(xvii) Break-even point is the point where

- (a) fixed and variable cost lines intersect
(b) fixed and total cost lines intersect
(c) variable and total cost lines intersect
(d) sales revenue and total expenses lines intersect

(xviii) A Pelton wheel is an

- (a) Axial flow impulse turbine
(b) Inward flow impulse turbine
(c) Outer flow impulse turbine
(d) Inward flow reaction turbine

(xix) Which of the following wage incentive plan guarantees minimum wage to a worker and bonus is paid for the fixed percentage of time saved?

- (a) Halsey Plan
(b) Gantt Plan
(c) Rowan Plan
(d) Emerson's Efficiency Plan



(xx) A counter flow heat exchanger is used to heat water from 20°C to 80°C using hot exhaust gas entering at 140°C and leaving at 80°C . The log mean temperature difference for the heat exchanger is

- (a) 80°C (b) 60°C
(c) 110°C (d) Can't determine.

SECTION - B

Answer any six questions : $5 \times 6 = 30$

2. What is fin effectiveness? What is range of possible value? How to make the fins more effective?

3. Explain the factors that affect the process of Carburetion ?
4. What is Couette flow ? Write the equations valid for such flow situations.
5. Give the approximate composition of LPG, Biogas, Producer gas, Water gas and Natural gas.
6. How is the specific speed of a turbine defined ?
7. How does a volute casing differ from a vortex casing for centrifugal pump ?
8. What are the methods adopted to increase the air supply for an engine ?
9. 'Planning and scheduling of mass production manufacturing differs from that of job order manufacturing'. Explain.

SECTION - C

Answer any *five* questions :

10×5=50

10. Engine oil at 100°C and velocity 0.1 m/s flows over both surfaces of 1 meter long flat plate maintained at 20°C. Determine :

(a) Hydrodynamic boundary layer thickness (δ) and thermal boundary layer thickness (δ_t)

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(10)

100

- (b) Local heat flux and shear stress
- (c) Total drag force on the plate.

11. A Syphon is consisting of a 20mm diameter tube drains water from a tank. The outlet end is 2m below the water surface and bend apex in the flexible tube is 1m above the water sample. Calculate the flow rate and pressure at the bend. (δ Water = 1000 kg/m³).

12. Derive the expression for network for diesel cycle expressed in terms of pressure-volume.

13. The temperature distribution at certain instant of time in a plane wall of 50 cm thick is given by the relation, $T = 450 - 500x + 100x^2 + 150x^3$. Where temperature 'T' in degree celsius and 'x' in metre, measured from the hot surface at 450°C. The thermal conductivity of the wall material is 10 w/mk. Calculate the rate of heat energy stored per unit area of the wall at that instant of time.

14. In viscous laminar flow through a circular pipe, show that the maximum velocity is twice the average velocity.

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(11)

[Turn over

15. A mass of 8 kg gas expands within flexible container such that Pv -relationship is of the form $Pv^{1.2} = \text{constant}$. The initial pressure is 1000 kPa and the initial volume is 1m^3 . The final pressure is 5 kPa. If the specific internal energy of the gas decreases by 40 kJ/kg, find the heat transfer in magnitude and direction.
16. An engine is to operate on diesel cycle with following data : maximum temperature 1400k, exhaust temperature 700k, state of air at the beginning of compression 0.1 MPa and 300k. Estimate the compression ratio, the maximum pressure, efficiency and rate of work output. (for 1 kg of air).

