CIVIL ENGINEERING

ESE TOPICWISE OBJECTIVE SOLVED

PAPER-II

1995-2022

IES MASTER PUBLICATION

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PREFACE

Engineering Services Examination (ESE) is the gateway to an immensely satisfying job in the engineering sector of India that offers multi-faceted exposure. The exposure to challenges and opportunities of leading the diverse field of engineering has been the main reason behind engineering students opting for Engineering Services as compared to other career options. To facilitate selection into these services, availability of numerical solution to previous years' paper is the need of the day.

It is an immense pleasure to present previous years' topic-wise objective solved papers of ESE. The revised and updated edition of this book is an outcome of regular and detailed interaction with the students preparing for ESE every year. The book includes solutions along with detailed explanation to all the questions. The prime objective of bringing out this book is to provide explanation to each and every question in such a manner that just by going through the solutions, ESE aspirants will be able to understand the basic concepts, and have the capability to apply these concepts in solving other questions that might be asked in future exams. Towards this end, this book becomes indispensable for every ESE aspiring candidate.

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CONTENT

21. **Statement (I):** Fluid pressure is a scalar quantity.

Statement (II): Fluid thrust always acts downwards.

IES-2015

22. The surface tension in a soap bubble of 50 mm diameter with its inside pressure being 2.5 N/m^2 above the atmospheric pressure is

(a) 0.0125 N/m (b) 0.0156 N/m

(c) 0.2 N/m (d) 0.0312 N/m

IES-2016

23. The Rheological behavior of concrete, when represented by shear stress vs rate of shear, is characterized as

(a) $\tau = \tau_0 + \mu.\dot{\gamma}$ (b) $\dot{\tau}_0 = \tau + \mu.\dot{\gamma}$

(c) $\frac{\tau}{\tau_0} = \mu.\dot{\gamma}$ (d) $\tau = \mu.\dot{\gamma}$

where : τ = shear stress,

τ_0 = (initial) yield value,

μ = at-point plastic viscosity

$\dot{\gamma}$ =at-point rate of shear

24. The surface tension of water at 20°C is 75 × 10^{-3} N/m. The difference in water surface within and outside an open-ended capillary tube of 1mm internal bore, inserted at the water surface, would nearly, be

(a) 7 mm (b) 11 mm

(c) 15 mm (d) 19 mm

25. Cavitation is likely to occur if

1. Pressure becomes very high
2. Temperature becomes low
3. Pressure at the specific points falls below vapour pressure
4. Energy is released with the onset of a high intensity wave due to noise and vibration of the machine.

Which of the above statements are correct?

(a) 1 and 3 (b) 2 and 3

(c) 3 and 4 (d) 2 and 4

26. **Statement (I):** The shear strain graph for a Newtonian fluid is linear.

Statement (II): The coefficient of viscosity μ of the fluid is not a constant.

IES-2017

27. Which of the following statements are correct?

1. Depression of mercury in a capillary tube is dependent on density and surface tension.
2. Modelling of flow-induced drag on a ship is done invoking both of Froude number 30. and Reynolds number.
3. Flow of a fluid in a narrow pipe is relatable to both Reynolds number and Cauchy number.
4. Formation and collapse of a soap bubble is analyzed through employing surface tension and external pressure.
5. Flow over the downstream slope of an ogee spillway can be affected by surface tension.

Select the correct answer using the codes given below:

(a) 1, 2 and 4 only (b) 1, 3 and 5 only

(c) 2, 3 and 4 only (d) 3, 4 and 5 only

IES-2018

28. **Statement (I) :** In areas where extreme cold conditions are a regular feature, and more so particularly in winter, it is necessary to use lighter oil for automobiles than in summer.

Statement (II) : 'Lighter' in Statement (I) refers to the oil density, which may be adjusted by admixtures.

29. The surface tension in a soap bubble of 20 mm diameter, when the inside pressure is 2.0 N/m^2 above atmospheric pressure, is

(a) 0.025 N/m (b) 0.0125 N/m

(c) 5 × 10^{-3} N/m (d) 4.25 × 10^{-3} N/m

30. A jet of water has a diameter of 0.3 cm. The absolute surface tension of water is 0.072 N/m and atmospheric pressure is 101.2 kN/m^2 The absolute pressure within the jet of water will be

(a) 101.104 kN/m^2 (b) 101.152 kN/m^2
(c) 101.248 kN/m^2 (d) 101.296 kN/m^2

31. A glass tube of 2.5 mm internal diameter is immersed in oil of mass density 940 kg/m^3 to a depth of 9 mm. If a pressure of 148 N/m^2 is needed to from a bubble which is just released. What is the surface tension of the oil?

(a) 0.041 N/m (b) 0.043 N/m
(c) 0.046 N/m (d) 0.050 N/m

IES-2019

32. A plate 0.025 mm distant from a fixed plate moves at 60 cm/s and requires a force of 0.2 kgf/m^2 to maintain this speed. The dynamic viscosity of the fluid between the plates will be nearly

(a) 9.2×10^{-10} $kgfs/cm^2$
(b) 8.3×10^{-10} $kgfs/cm^2$
(c) 7.4×10^{-10} $kgfs/cm^2$
(d) 6.5×10^{-10} $kgfs/cm^2$

IES-2021

33. What is the minimum size of glass tube that can be used to measure water level if the capillary rise in the tube is to be restricted to 2 mm? (Take surface tension of water in contact with air as 0.073575 N/m)

(a) 1.5 cm (b) 1.0 cm
(c) 2.5 cm (d) 2.0 cm

IES-2022

34. The pressure outside the droplet of water of diameter of 0.04 mm is 10.32 N/cm^2 (atmospheric pressure). What is the pressure within the droplet if surface tension is 0.0725 N/m of water ?

(a) 11.045 N/cm^2 (b) 10.32 N/cm^2
(c) 9.45 N/cm^2 (d) 8.595 N/cm^2

35. What is the viscosity of a liquid whose kinematic viscosity is 6 stokes and specific gravity is 1.90?

(a) 1.14 poise (b) 11.40 poise
(c) 0.114 Ns/m^2 (d) 11.40 Ns/m^2

ANSWER KEY

1.	(a)	**8.**	(b)	**15.**	(b)	**22.**	(b)	**29.**	(c)
2.	(c)	**9.**	(b)	**16.**	(d)	**23.**	(a)	**30.**	(c)
3.	(a)	**10.**	(d)	**17.**	(c)	**24.**	(c)	**31.**	(a)
4.	(c)	**11.**	(c)	**18.**	(d)	**25.**	(c)	**32.**	(b)
5.	(a)	**12.**	(b)	**19.**	(b)	**26.**	(c)	**33.**	(a)
6.	(c)	**13.**	(a)	**20.**	(d)	**27.**	(a)	**34.**	(a)
7.	(a)	**14.**	(a)	**21.**	(c)	**28.**	(c)	**35.**	(b)

$$\Delta p = \frac{8\sigma}{d}$$

(5) Flow over the downstream slope of an ogee spillway can not be affected by surface tension.

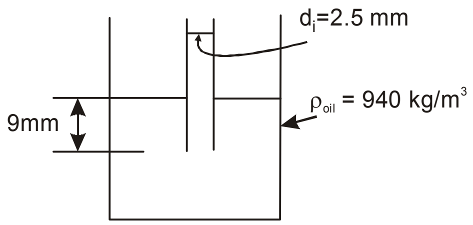
So option (a) 1, 2 and 4 only.

28. (c) Oil is thin when heated and thickens as it is cooled even to the point that at very cold temperature, oil would thicken such that, it no longer lubricate the engine. Therefore lighter viscosity motor oils is essential when season changes from summer to winter to prevent catastrophic engine failure.

29. (c)
$$\Delta P = \frac{8\sigma}{D}$$
$$2\text{N/m}^2 = \frac{8\sigma}{0.02}$$
$$\Rightarrow \sigma = 5 \times 10^{-3} \text{ N/m}$$

30. (c)
$$d_{jet} = 0.3\text{cm}$$
$$\sigma_{water} = 0.072 \text{ N/m}$$
$$P_{atm} = 101.2\text{N/m}^2$$
$$\Delta P = \frac{2\sigma}{D}(\text{for jet})$$
$$P_{jet} - P_{atm} = \frac{2 \times 0.072\text{N/m}}{0.3 \times 10^{-2}}$$
$$= 48 \text{ N/m}^2$$
$$= 0.048 \text{ KN/m}^2$$
$$P_{jet} = 101.2 + 0.048$$
$$= 101.248 \text{ KN/m}^2.$$

31. (a)

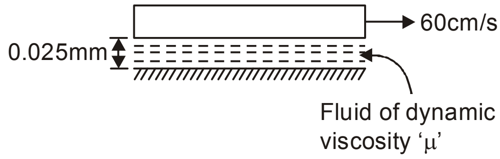


$$(P_i - P_0) = \frac{4\sigma}{D}$$

Now $P_0 = 940 \times 9.81 \times 9 \times 10^{-3} = 82.99\text{N/m}^2$

$$\Rightarrow 148 - 82.99 = \frac{4 \times \sigma}{2.5 \times 10^{-3}}$$
$$\Rightarrow \sigma = \frac{65.01 \times 2.5 \times 10^{-3}}{4} \approx 0.041\text{N/m}$$

32. (b)



$$\tau = 0.2 \text{ kg.f/m}^2$$
$$\tau = \mu\frac{du}{dy}$$
$$0.2\frac{\text{kg.f}}{\text{m}^2} = \mu \times \frac{600\text{mm/sec}}{0.025\text{mm}}$$
$$\mu = 8.33 \times 10^{-6}\frac{\text{kg.fs}}{\text{m}^2}$$
$$= 8.33 \times 10^{-10}\text{kgfs/cm}^2$$

33. (a) Capillary rise $= \dfrac{4\sigma\cos\theta}{\gamma \times d} = h$

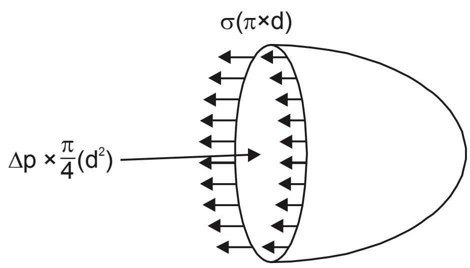
If $h \leq 2$ mm

$$\Rightarrow \frac{4\sigma\cos\theta}{\gamma_w d} \leq 2\text{ mm}$$
$$d \geq \frac{4\sigma\cos\theta}{\gamma_w \times 2\text{ mm}}$$
$$d_{min} = \frac{4\sigma\cos\theta}{\gamma_w \times 2\text{ mm}}$$

For water-glass contact, $\theta = 0$

$$\Rightarrow d_{min} = \frac{4\sigma}{\gamma_w \times 2\text{ mm}}$$
$$= \frac{4 \times 0.073575\text{ N/m}}{9810\text{ N/m}^3 \times 2 \times 10^{-3}\text{ m}}$$
$$d_{min} = 0.015 \text{ m}$$
$$= 15 \text{ mm} = 1.5 \text{ cm}$$

34. **(a)**



$$\Delta p \times \frac{\pi}{4}d^2 = \sigma \times \pi d$$

where,

Δp = $(p_{inside} - p_{outside})$

= pressure difference between inside and outside of water bubble,

d = diameter of the bubble

= 0.04 mm

σ = surface tension

= 0.0725 N/m (given)

p_{inside} = 10.32 N/cm^2 (given)

$$\Rightarrow \quad \Delta p = \left(\frac{4\sigma}{d}\right) = \left(\frac{4 \times 0.0725}{\left(\frac{0.04}{10}\right) \times 100}\right)$$

$$= 0.725 \text{ N/cm}^2$$

$$\Rightarrow \quad p_{inside} - p_{outside} = 0.725$$

$$\Rightarrow \quad p_{inside} = (10.32 + 0.725) = 11.045 \text{ N/cm}^2$$

35. (b)

Given, kinematic viscosity (ν) = 6 stokes

Specific gravity (G) = 1.9

Kinematic viscosity (ν)

$$= \frac{\text{dynamic viscosity } (\mu)}{\text{density } (\rho)}$$

$$\Rightarrow \quad \sigma = \frac{\mu}{1.9 \times 1 \text{ gm/cc}}$$

$$\Rightarrow \quad \mu = (1.9 \times 6) \text{ poise} = 11.40 \text{ poise}$$

Note: 1 stokes = 1 cm^2/sec

$$1 \text{ poise} = \frac{1 \text{ gm}}{\text{cm} - \text{sec}}$$

$$10 \text{ poise} = 1\frac{\text{Ns}}{\text{m}^2}$$