

## Course outline

How does an NPTEL online course work?

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Week 5

 Resonance Frequencies

 Spectral Response of an Optical Resonator

 Resonator Loss and Cavity Lifetime

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# Assignment 5

The due date for submitting this assignment has passed.

**Due on 2021-02-24, 23:59 IST.**

As per our records you have not submitted this assignment.

**Instructions:**

1. Answer all questions; all questions carry equal mark.
2. All symbols have their usual meanings.
3. Only one of the options is correct.
4. Take care of the units in numerical problems, to match with the units given in the options (of MCQs), and the units in which answers have to be entered (in fill in the blank type of questions).
5. In the fill in the blank type of questions, only the numerical values have to be entered.

**NOTE:** You can see the correct answers after the last date of submission. Marks obtained in this quiz will be counted towards your final score. You can take the quiz and submit it any number of times, and the latest submitted answers will be taken as your final submission.

- 1) State whether the following statement is TRUE or FALSE? **1 point**

In general, lasers having a closed resonator are more monochromatic than lasers having an open resonator, because number of modes in a closed resonator are far larger than that in an open resonator.

- TRUE  
 FALSE

No, the answer is incorrect.  
 Score: 0

Accepted Answers:  
 FALSE

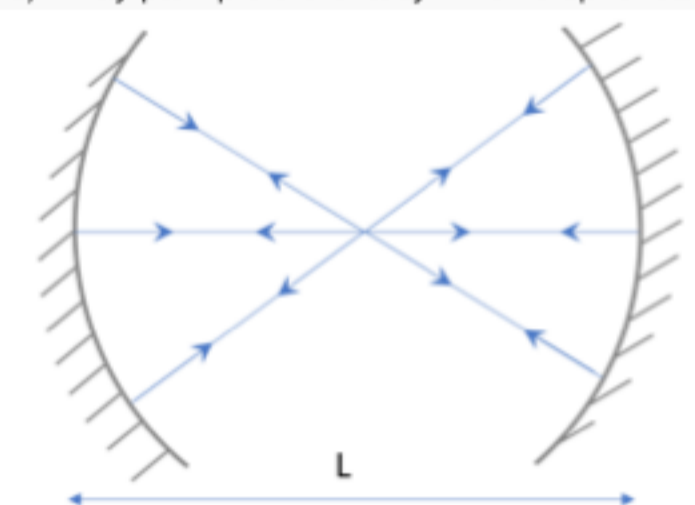
- 2) Which one of the following statements regarding open resonators is incorrect? **1 point**

- In a plane mirror resonator, only one type of ray path (which is perpendicular to the two mirrors forming the resonator) is confined.  
 More than one type of ray path may be confined in a spherical mirror resonator.  
 In a ring-resonator, resonance always occurs for ray paths in only one direction (clockwise or anti-clockwise).  
 Fiber resonators are 'open resonators' because light propagates in the fiber as guided-modes (in the forward and backward direction).

No, the answer is incorrect.  
 Score: 0

Accepted Answers:  
 In a ring-resonator, resonance always occurs for ray paths in only one direction (clockwise or anti-clockwise).

- 3) Ray path picture of a symmetric spherical mirror resonator is shown below: **1 point**



Identify the type of the spherical mirror resonator, and the corresponding separation between the mirrors (L)?

Given: f is the focal length of each spherical mirror.

- Confocal mirror resonator,  $L = 2f$   
 Concentric mirror resonator,  $L = 2f$   
 Confocal mirror resonator,  $L = 4f$   
 Concentric mirror resonator,  $L = 4f$

No, the answer is incorrect.  
 Score: 0

Accepted Answers:  
 Concentric mirror resonator,  $L = 4f$

- 4) A plane mirror resonator of length 20 mm has a cavity refractive index 3.2. The Free Spectral Range (FSR) of the resonator is \_\_\_\_ GHz.

(Enter the answer up to two decimal places)

No, the answer is incorrect.  
 Score: 0

Accepted Answers:  
 (Type: Range) 2.24,2.44

**1 point**

- 5) In a particular plane mirror resonator with no resonator loss, the accumulated phase of the electric field per round trip is  $\phi = \pi/6$ . The minimum number of round trips after which the magnitude of the resultant electric field will be the same as that of the initial electric field is \_\_\_\_.

(Answer must be an integer)

No, the answer is incorrect.  
 Score: 0

Accepted Answers:  
 (Type: Numeric) 12

**1 point**

- 6) The phasor diagram of the electric field build-up over several round trips in a plane mirror resonator is shown below: **1 point**



If the electric field after one round trip is  $E_0 r e^{-i\phi}$ , then which one of the following is correct?

( $E_0$  is the initial electric field)

- $r=1, \phi=0, 2m\pi$   
  $r=1, \phi \neq 0, 2m\pi$   
  $r < 1, \phi=0, 2m\pi$   
  $r < 1, \phi \neq 0, 2m\pi$

No, the answer is incorrect.  
 Score: 0

Accepted Answers:  
 $r < 1, \phi=0, 2m\pi$

- 7) In Question no. 7 above, the net intensity built-up in the resonator after a large number of round trips is  $9|E_0|^2$ . The reflectivity (R) of each mirror is \_\_\_\_%.

(Assume that there is no other cavity loss)

(Enter the answer up to two decimal places)

No, the answer is incorrect.  
 Score: 0

Accepted Answers:  
 (Type: Range) 65.67 ,67.67

**1 point**

- 8) If the loss per roundtrip in an optical resonator is 16%, then the Finesse of the resonator is \_\_\_\_.

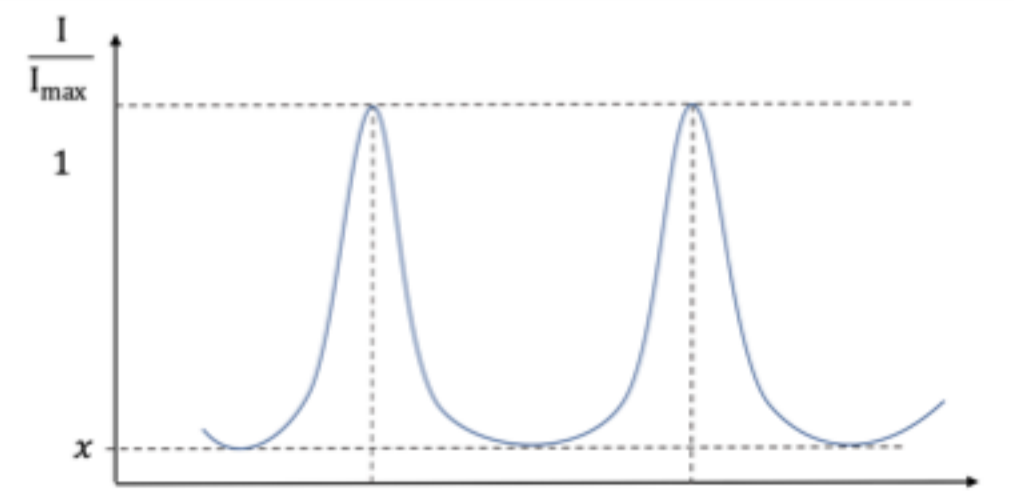
(Enter the answer as an integer)

No, the answer is incorrect.  
 Score: 0

Accepted Answers:  
 (Type: Range) 34,38

**1 point**

- 9) Normalized intensity spectrum of a resonator having Finesse  $F = 2$ , is shown below.



The value of x is \_\_\_\_.

(Enter the answer up to two decimal places)

No, the answer is incorrect.  
 Score: 0

Accepted Answers:  
 (Type: Range) 0.37,0.39

**1 point**

- 10) The cavity lifetime of a resonator, with a resonance wavelength of 1550 nm, is 40 ns. The Q factor of the resonator is \_\_\_\_  $\times 10^7$ . Assume refractive index of medium to be 1.

(Enter the answer upto two decimal places)

No, the answer is incorrect.  
 Score: 0

Accepted Answers:  
 (Type: Range) 4.61,4.99

**1 point**